

Draft for ATAC Review

Revised: October 7, 2005

Maine Air Toxics Priority List & Basis Statement

Prepared For Review by the Air Toxics Advisory Committee

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This *Revised Draft of the Prioritized List of Air Toxics For the State of Maine, & Basis Statement* was drafted by David Wright of the Maine Department of Environmental Protection. However, this draft document is not intended to represent the opinions of the Maine Department of Environmental Protection. Rather, the document is the last effort in a failed attempt at reaching a consensus recommendation from the subcommittees to the full Air Toxics Advisory Committee (ATAC). The ATAC is a group having an interest in Air Toxics that is composed of community, government, industrial and environmental organizations. **This document has not been endorsed by the Air Toxics Advisory Committee or its subcommittees.**

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Additional Information on the Maine Air Toxics Initiative is available from:
<http://www.maine.gov/dep/air/toxics/mati.htm>

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1. EXECUTIVE SUMMARY

1.1 The MATI Process

1.1.1 The Need and Goals of the Program

The Maine Department of Environmental Protection (MEDEP) initiated the Maine Air Toxics Initiative (MATI) in 2002. At that time MEDEP was completing implementation of a host of federal Air Pollution standards, which had significantly reduced the exposure of Maine Citizens to Air Toxics (ATs). The MEDEP had also reviewed the recently released National Air Toxics Assessment (1996 NATA), a risk assessment screening tool that looked at Air Toxics at the county level across the USA. The 1996 NATA was developed by the United States Environmental Protection Agency's (EPA), and it suggested that Maine citizens still faced an unacceptable risk from certain Air Toxics. In light of the 1996 NATA findings, MEDEP policy questions and citizen concerns, MEDEP formed a stake-holder group to complete a holistic assessment of Maine's Air Toxics risks. The MATI process is depicted in Figure 4, and was intended by the MEDEP to:

- verify whether or not the 1996 NATA results seem reasonable, considering state and federal air emission estimates and ambient air monitoring results, and then if necessary:
- identify which Air Toxics are the most responsible for creating health risks,
- identify the source of those pollutants, and
- Develop strategies to reduce the risk.

1.1.2 The Stakeholder Group

In 2003 MEDEP convened a group of people representing the varied interests in Air Toxics to form the Air Toxics Advisory Committee (ATAC). The ATAC met on several occasions in 2003 and early 2004 to undertake the first step in the MATI scope of work, which was to develop a Maine Air Toxics Priority List.

The ATAC established three subcommittees to undertake the technical work necessary to develop the priority list and basis statement. The hope was that the subcommittees could develop a consensus recommendation for approval by the full ATAC. However, the subcommittees were unable to reach agreement on a recommendation. The three ATAC subcommittees were: (1) an inventory subcommittee to provide HAP emissions data; (2) a toxicity subcommittee to provide toxicity factors, and (3) a benchmarking subcommittee to screen air toxics against health benchmarks. The methods, assumptions and results of the analysis of each of the subcommittees are contained in this Basis Statement. These subcommittees also looked at other factors, including air monitoring data, transport of HAPs, persistence, bioaccumulation and unknowns to develop a final list of air toxic priorities.

1.1.3 Approach Taken to Develop the ATPL

Given the state's limited resources, the ATAC determined that a full modeling of emissions and risk assessment for all Air Toxics in the state was not feasible. Rather, the ATAC decided to develop a toxicity-weighted emissions inventory. The relative risks on this list would then be compared to the estimates of risk that EPA had derived for 31 Air Toxics. Available air monitoring data would be reviewed as a reality check. Finally other factors would be qualitatively considered. These other factors included persistence, bioaccumulation and the lack of data for many pollutants. Each of these steps is described in more detail below, and the whole process is depicted in .

1.2 The MATI Inventory

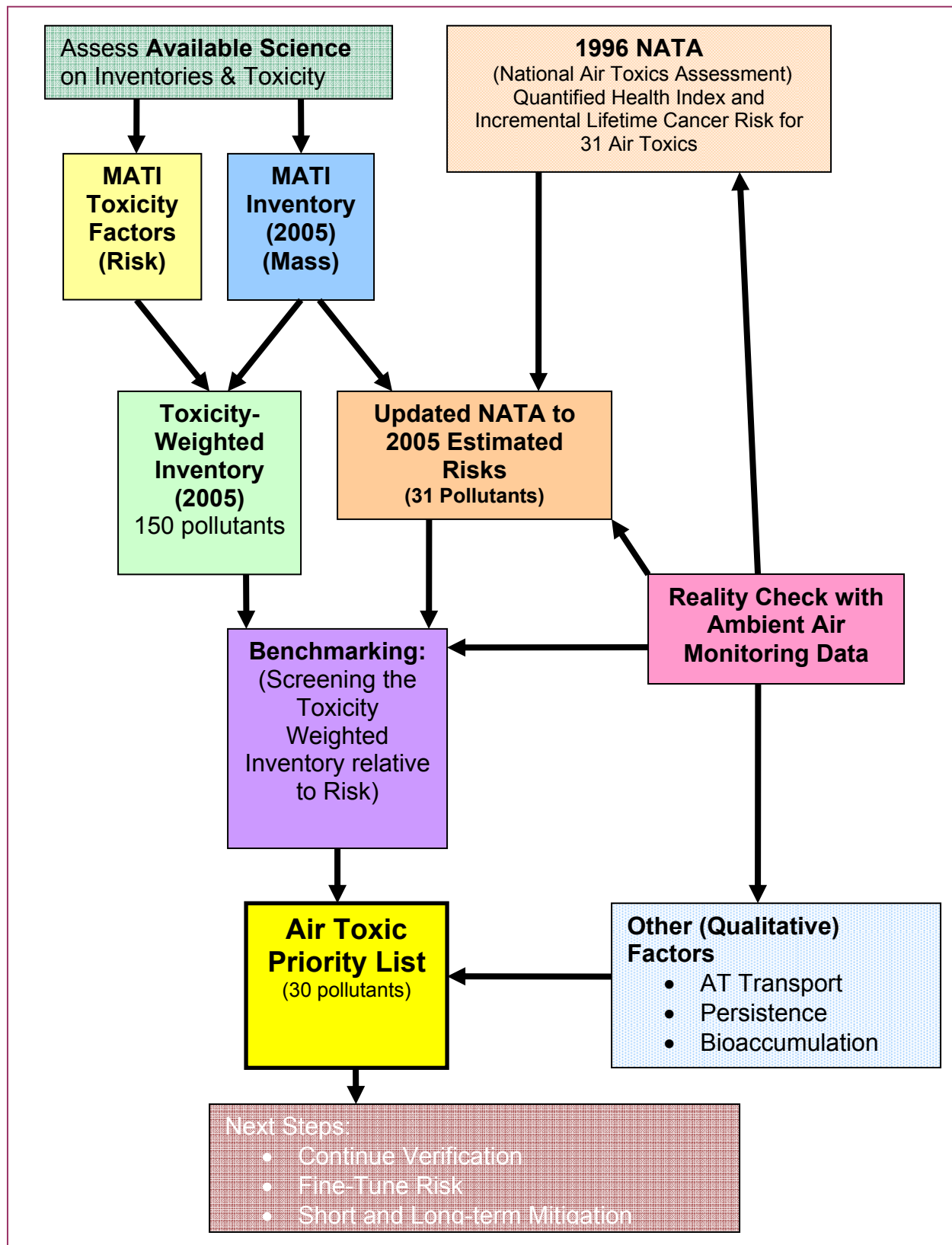
The starting point for developing an Air Toxics Priority List was an accurate inventory. The inventory subcommittee determined that no existing inventory accurately quantified current HAP emissions in Maine. Therefore, the subcommittee developed the MATI Inventory. The MATI inventory is an estimate of 2005 HAP emissions. The MATI inventory evolved from the 1999 National Emissions Inventory (1999 NEI) for Maine, which was supplemented with corrected and updated data. The MATI inventory includes estimates from all source sectors: Point, Area, and Mobile sources. The inventory is based on Maine specific activity levels (amount of fuel burned, acres burned in forest fires, facility specific emission reports, vehicle miles traveled, etc.). The subcommittee reduced uncertainty in calculation methods, activity data, and emission factors whenever possible by following established EPA protocols. The subcommittee "back-filled" emission factors from one source category to similar source categories for which no factor had been included in the 1999 NEI. For example, emission factors for commercial wood combustion were applied to residential wood combustion, and so forth. Additionally, the subcommittee reduced emission estimates for source categories that were significantly over-estimated in the 1999 NEI. Thus the inventory subcommittee considers the MATI inventory to be significantly more accurate than the 1999 NEI.

1.3 Toxicity-Weighting the MATI inventory

In order to weight emissions with toxicity, the ATAC needed a toxicity factor. The Toxicity Subcommittee was chaired by DHHS staff, and based the MATI Toxicity Factors on those in EPA's Risk-Screening Environmental Indicators (RSEI) model. The RSEI toxicity factors are based on a standard hierarchy of toxicity information, and a common risk weighting scale. Maine DHHS reviewed the underlying toxicology data for the RSEI values¹ and updated them as appropriate. For missing toxicity factors, DHHS used the same protocols that were used to derive the RSEI toxicity factor, except for POM and Diesel PM. These two factors were developed in subcommittee by reviewing the available toxicological literature, as discussed in detail in the basis statement.

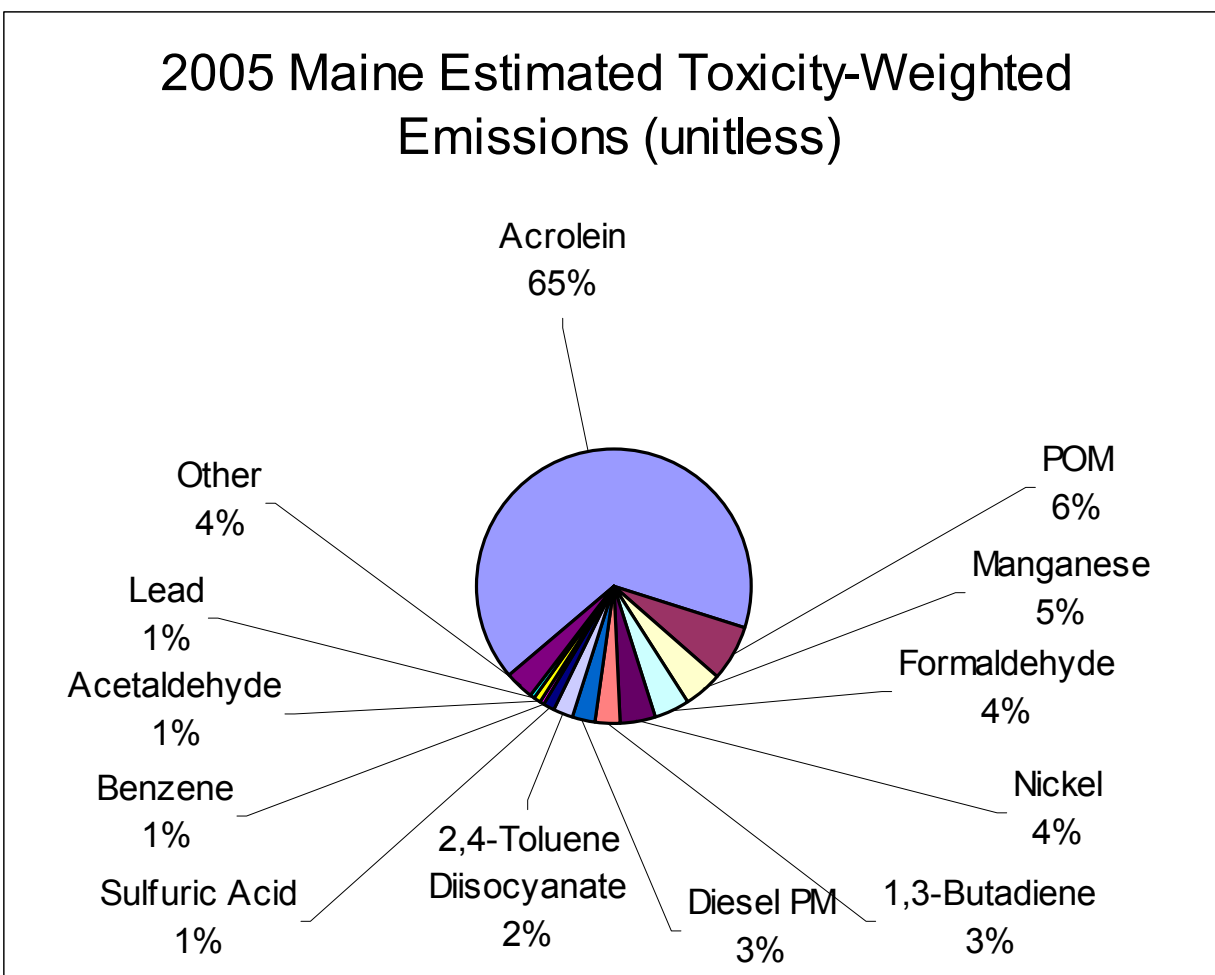
¹ Zeeman, Catherine Q.T., Memorandum of February 2, 1993, "Interim Ambient Air Guidelines" (Maine DEP, Bureau of Air Quality, 17 SHS, Augusta, ME 04333-0017)

Figure 1: Schematic of the Process Used to Develop the Air Toxics Priority List



The ATAC then multiplied pollutant emissions times its respective toxicity factor to derive a toxicity-weighted emission. This allowed the ATAC to evaluate pollutants with differing toxicity on a common basis. For example, many more pounds of Toluene than 2,4- Toluene diisocyanate (TDI) were emitted in 2005, but due to the much greater toxicity of TDI, this pollutant has a higher toxicity weighted emission. By comparing the toxicity-weighted emissions, the ATAC was able to develop a relative ranking of pollutants, as shown in Figure 3.

Figure 2:



1.4 Benchmarking Toxicity Weighted Emissions

The toxicity-weighted inventory, however, was only a relative ranking of emissions based on risk. It did not quantify the actual risk to public health, and thus is not useful in determining which pollutants, if any, warranted reductions. To develop an approximation of actual risk to public health, the Benchmarking Subcommittee

evaluated the 1996 National Air Toxics Assessment (1996 NATA). The 1996 NATA was a nation-wide screening-level assessment of the health risks posed by 31 air toxics. The purpose of the 1996 NATA was to help citizens determine where to focus efforts for further evaluation.

First, the benchmarking subcommittee roughly updated the 1996 NATA risk to current risk. This was done by simply applying the ratio of 1996 emissions and risk to current emissions (see Equation 2). Next, the benchmarking subcommittee summed risks posed by individual pollutants and pollutant mixtures in each county. The subcommittee now had quantified risks, on a county-wide basis, for 31 of the 148 compounds on the Toxicity-Weighted inventory list. The risks posed by the 31 NATA compounds were used to screen, or benchmark, Maine's AT priority list relative to actual risk levels. It should be noted that risks over most of the county will be lower than assessed using this approach and risks will be much higher in hot-spot locations.

It should be noted that the benchmarking and inventory subcommittees completely disagreed on the "acceptable risk" level used in screening pollutants during this phase of the project. Some members favored using an acceptable risk level that found that one or no pollutants posed an unacceptable risk on the county-wide level. The other members of the subcommittee favored a more stringent screening standard. All members agreed that the risks posed by Air Toxics in localized hot-spots needs further evaluation.

1.5 Reality Check With Ambient Air Monitoring Data

Then, the subcommittees reviewed available information on air monitoring data to determine that the above risk calculations appear to be in the right ball-park. The data confirms that further action is needed in hot-spot locations. The monitoring data also suggests that there is a local and a regional component that creates the air toxic concentrations in Maine. Thus any solutions will have to not only target Maine emissions, but also emission sources outside of the state that are transported into Maine.

1.6 Consideration of Persistence, Bioaccumulation, and Other Factors

The ATAC also added compounds onto the ATPL using other factors. The toxicity-weighting procedures described above considered risks posed by current emissions. Some compounds persist for long periods in the environment, so that people can be exposed to them long after the pollutant is emitted. For this reason, several pollutants that were low on the toxicity-weighted list had relatively high risks in the NATA risk assessment. These so called "background" Air Toxics were added to the ATPL.

The above risk evaluations only assessed impacts from breathing Air Toxics. However, heavier pollutants will settle out of the atmosphere onto land and water, where they could be incidentally ingested, or incorporated into food that is eaten. Some of these pollutants also bioaccumulate. That is, biota tend to uptake the pollutant faster than it is excreted, so that concentrations within the plant or animal are higher than the surrounding environment. It was beyond the scope of this screening analysis to

evaluate the actual risk posed by these persistent, depositional pollutants. However, these pollutants were retained on the ATPL for further assessment, even though the risk from inhalation of current emissions was low.

Finally, some compounds have only recently been suggested to pose a possible air toxics risk, and little is known about them. Several additional compounds were added to the list due to these unquantifiable factors.

1.7 The Air Toxics Priority List

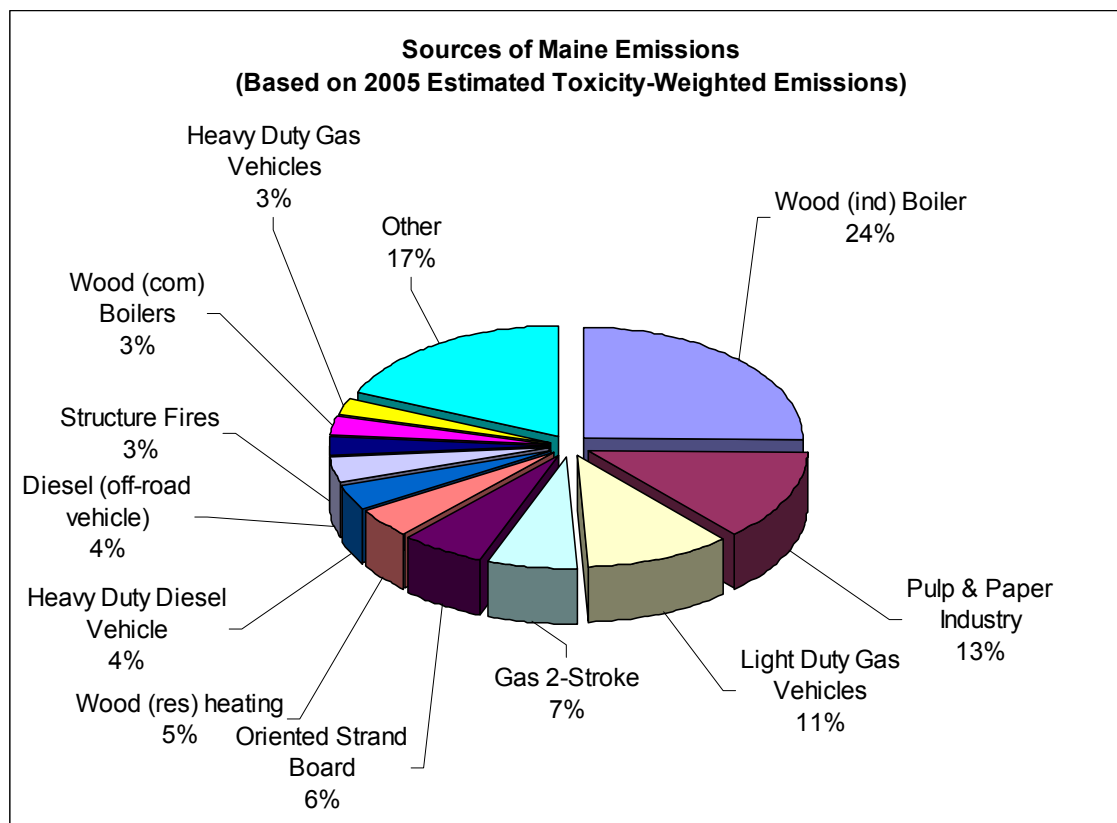
The final Air Toxics Priority List is shown in Table 21 on page 92 (note, this list has not been reviewed nor endorsed by the full Air Toxics Advisory Committee). While the uncertainty of data used to derive the list was minimized as much as possible through an iterative, stake-holder driven process, the data is not as robust as scientists would like. However, the list represents the best available information at this time. The ATAC envisions that this list will be altered as new information comes to light and circumstances change.

It should also be noted that the inventory subcommittee completely disagrees on the emission estimation for the number one compound, acrolein. A sensitivity analysis conducted by the inventory subcommittee shows that if one emission factor were used for large wood combustion sources, acrolein emissions would be 60% lower. If another factor were used, acrolein emissions from wood fired boilers would be 260% higher. Regardless of the emission factor used, acrolein will still have the highest toxicity-weighted emissions.

1.8 Sources of Air Pollutants

It is also possible to assess the source of current emissions using the MATI inventory. It is important to note that the way that categories are lumped together greatly influences the relative ranking of source categories. Figure 3 depicts one possible combination.

Figure 3:



1.9 Recommendations for Further Action

As the ATAC moves forward, it must be cognizant of inherent uncertainties in the development of the ATPL, and take these into consideration when it develops solutions. Further inventory refinement and risk assessment may be necessary before a solution can be fully considered. The assessment in this document should help the ATAC to focus efforts towards those areas where action is needed. This action may include refinement of actual risks, and/or risk mitigation.

The ATAC has (not) come to consensus on the following additional actions that should be undertaken:

- 1) The ATAC should move forward to complete the steps in the MATI Scope of Work.
- 2) MEDEP should develop an "Acceptable Risk" policy for Air Toxics through a stakeholder process.
- 3) MEDEP should develop a process to proactively evaluate unknown contaminants that may become future contaminants of air, water, land or food.
- 4) MEDEP should expand ambient air monitoring as necessary to ensure that the pollutants on the ATPL are appropriately monitored.
- 5) MEDEP should adopt the improvements in inventory development that were identified by the ATAC, and recommend appropriate improvements to EPA for the national inventory program.

2. THE MAINE AIR TOXICS INITIATIVE PROCESS

The Maine Department of Environmental Protection (MEDEP) initiated the Maine Air Toxics Initiative (MATI) in 2002. At that time MEDEP was completing implementation of a host of federal Air Pollution standards, which had significantly reduced the exposure of Maine Citizens to Air Toxics (ATs). The MEDEP had also reviewed the recently released National Air Toxics Assessment (1996 NATA), which was undertaken by the United States Environmental Protection Agency's (EPA), and which suggested that Maine citizens still faced an unacceptable risk from certain Air Toxics. In light of the 1996 NATA findings and citizen concerns, MEDEP formed a stake-holder group to complete a holistic assessment of Maine's Air Toxics risks. MATI, as depicted in Figure 4, is a holistic assessment of Maine's Air Toxics risks. The goal is to efficiently direct available resources towards reducing exposure of all Maine Citizens to acceptable² levels of Air Toxics. Maine MEDEP intended the MATI to:

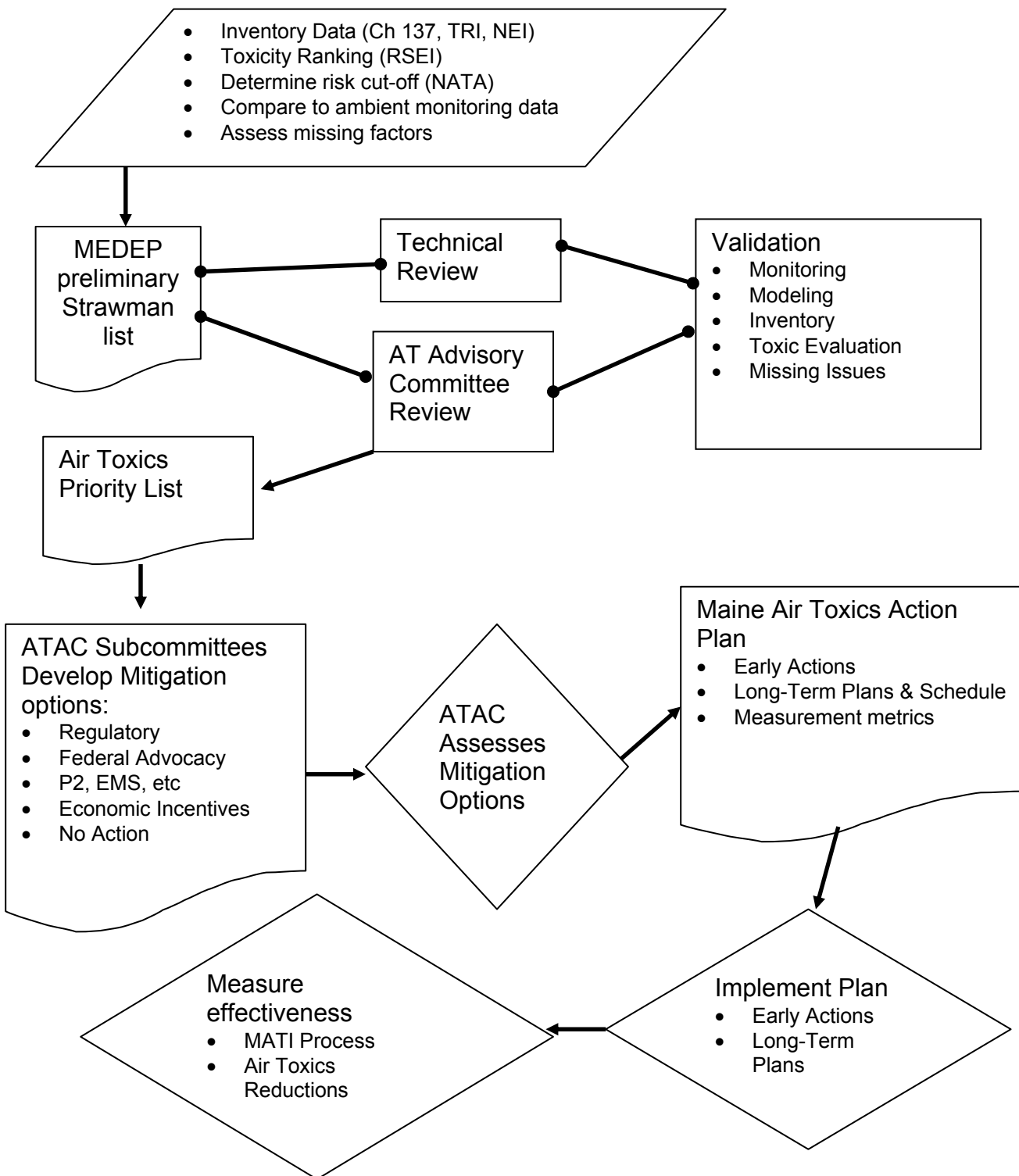
1. verify whether or not the 1996 NATA results seem reasonable, considering state and federal air emission estimates and ambient air monitoring results.
2. If necessary and appropriate, then:
 - a. identify which Air Toxics are the most responsible for creating health risks,
 - b. identify the source of those pollutants, and
 - c. create cost effective solutions to reduce the risk.

The solutions would include early actions and a long-term targeted strategy with clear implementation goals and timeframes. These strategies could include economic incentives, targeted pollution prevention programs, new legislation at the state level, or partnering with regional agencies to resolve interstate issues.

Due to the multitude of interests involved in Air Toxics, and the complexity of the issue, Maine DEP believed that the MATI had the best chance of a success if it was undertaken by a stakeholder committee. By using similar stakeholder processes, MEDEP has gained a fuller understanding of other environmental problems and solutions, while fostering cooperation with Maine citizens in resolving the issue. EPA agreed with this approach and awarded MEDEP with a Healthy Communities Grant to fund an independent, outside facilitator for the initiative. MEDEP then convened a group of people representing the varied interests in Air Toxics to form the Air Toxics Advisory Committee (ATAC). ATAC is composed of community, government, industrial and environmental organizations. The organizations and people forming the ATAC, along with subcommittee assignments, are included on the MATI website at: <http://www.maine.gov/dep/air/toxics/mati.htm>.

² See Section 2.2.2 for a fuller discussion of "acceptable risk".

Figure 4: The Maine Air Toxics Initiative Process



The ATAC met for the first time on November 7, 2003, to discuss ATAC Logistics and the proposed MATI process. The ATAC agreed on a Scope of Work³ for the MATI, reviewed the 1996 NATA and critiqued a Strawman Air Toxics Priority List. ATAC members that were interested in a detailed discussion of the NATA and the derivation of the Strawman List met again on December 12, 2003. At the December meeting, the ATAC determined that, while reserving the right to challenge the assumption that Air Toxics posed an unacceptable risk to Maine Citizens, it was prudent to begin the development of an Air Toxics Priority List. Further, ATAC determined that it could build upon the process that Maine MEDEP used to develop the Strawman List. Finally, ATAC directed the MEDEP to undertake a series of activities to convert the strawman list into a Preliminary Air Toxics Priority List.

MEDEP then developed a Preliminary Air Toxics Priority list, which was discussed at a February 12, 2004 meeting. During the February meeting, the ATAC formed two subcommittees. One subcommittee was tasked with refining the emissions inventory used as the basis for the ATPL, so that the inventory more closely reflected current Maine conditions. Another subcommittee was formed to explore how best to assess the risks posed by both particulate matter (PM_{2.5}) from mobile diesel sources, and Polycyclic Aromatic Hydrocarbons (PAHs). These subcommittees met several times to discuss these issues, and came to a consensus decision which was reflected in a draft Air Toxics Priority List and Basis Statement.

The full ATAC met on May 25, 2004 in an attempt to reach consensus on whether or not air toxics posed an unacceptable risk, and if so, what pollutants were responsible for the risk. At this meeting, the ATAC determined that further inventory work was necessary, and that an alternative method was needed to “Benchmark” the toxicity-weighted emissions (see Section 5 beginning on page 52). However, the ATAC agreed on a general approach to developing the priority ranking, and assigned some new personnel to the inventory subcommittee and created a benchmarking subcommittee. The inventory and benchmarking subcommittees worked to develop, in conjunction with the toxicity subcommittee’s findings, the Air Toxics Priority List shown in Table 21. However, the subcommittees were unable to form a consensus recommendation.

The full ATAC met again on ??? and reached consensus on ??? {NOTE: This paragraph to be completed after the full ATAC meeting.}

2.1 Overview of the Process Used To Derive the Air Toxics Priority List

The most direct approach to determine which air contaminants pose the greatest risk, would be to measure all the contaminants found in the air, and then conduct an assessment of the risk that they pose. However, current air monitoring systems can not detect many air toxics at the low levels that might pose a risk, and insufficient data is

³ Maine Air Toxics Initiative Proposed Scope of Work & Schedule, Revision of November 5, 2004 (Air Toxics Program, Bureau of Air Quality Control, Maine Department of Environmental Protection, 17 State House Station, Augusta, ME 04333-0017. http://www.maine.gov/dep/air/emissions/MATI_Scope_of_Work_11-7-03.rtf)

available regarding ambient levels of air toxics in Maine. Therefore, the ATAC had to use an alternative approach.

The next best approach would have been to estimate air pollutant releases to the air, determine the resulting concentration that people would breathe, assess the risks posed by breathing the air, and then rank chemicals accordingly. The EPA used this approach in the National Air Toxics Assessment (see Section 3.2.2 below) but due to the extensive modeling needed for each pollutant in each step of the process, the EPA limited the assessment to 31 compounds. The ATAC did not have the time or resources to conduct a similar assessment for the 188 HAPs, or a larger number of Air Toxics. Rather, ATAC used a toxicity-weighted emissions approach to approximate these more detailed modeling approaches.

The first step that ATAC took in deriving the Air Toxics Priority list, was to look at information from air emissions inventories, and rank pollutants based on the tons emitted to the air in a year. The ATAC then assessed how toxic each chemical was, and ranked emissions based on a combination of the mass released, and its toxicity, (see section 4 and Equation 1). This prioritized the ATs relative to each other, but did not determine which pollutants were not posing an actual risk problem and therefore did not need follow-up action. To address this issue, the Department compared Maine's ranked list to the compounds assessed in the National Air Toxics Assessment (see section 5). In this way the ATAC

Sidebar 5: Interrelationship of Emissions Inventories, Modeling and Ambient Air monitoring

Emission Inventories, modeling, and ambient air monitoring are all used to determine the concentration of pollutants in the ambient air. Ambient air monitoring can be used to document actual exposure concentrations, or the amount of an air toxic in the ambient air that a person might breathe. However, for most air toxics, analytical methods have not been developed that can detect ATs in the ambient air at the low levels that can cause health impacts. Therefore, detectable ATs are often used as indicators for other compounds. Additionally, air monitoring by itself can not tell us where an air toxic originated, so we can not determine how to stop the release.

Air Modeling is often used to help track down the source of a contaminant, and predict the concentration of ATs that can not be accurately monitored in low concentrations. Models can also be used to help predict concentrations of ATs at locations that are not monitored. However, calibration and verification of a model's accuracy depends on actual ambient air monitoring results. Additionally, models require that accurate meteorological and emissions data be input into the model.

Emission inventories are used as model inputs. Feedback from modeling results and ambient air monitoring, however, can also help detect sources of contaminants that have not been accounted for in emissions modeling. In this way, monitoring, modeling, and emissions inventories are the three legs of the stool upon which good air quality assessment rests.

was able to “benchmark”, or calibrate, Maine’s ATPL. Finally, the ATAC took a real world assessment of the list, to determine which factors had not been adequately considered. The list was then adjusted to account for these missing factors (see section 5.3.1 on page 63). The overall process that was used to derive the ATPL is shown in Figure 6.

One issue that must still be resolved because ATAC used this approach is the identification of hot-spots, or areas of localized risk.

2.2 Overview of Protocols for Assessing Risk & Screening Pollutants

2.2.1 Calculating Risk from Exposure to Air Toxics

The MEDEP uses standard MEDEP and EPA Guidance to measure risk associated with breathing air toxics. Generally, risks are assessed separately for non-carcinogenic impacts and carcinogenic impacts. This is because non-carcinogenic impacts usually have a threshold, below which exposure to a given pollutant will not cause an adverse health effect. Carcinogens, on the other hand, are non-threshold pollutants, meaning that there is some risk of an adverse health effect at any level of exposure, but that the risk decreases with decreasing exposure concentrations of the pollutant.

MEDEP uses the Health Index (HI) to determine if a non-carcinogen will pose a risk to a person or population, after they are exposed to that compound over a certain amount of time, usually a lifetime⁴. Below a HI of 1, no adverse effects will occur, above a HI of 1, adverse health effects may occur. Specifically, MEDEP estimates the HI by taking the Average Daily Dose for the chronic exposure period, and dividing it by the chronic Reference Dose.

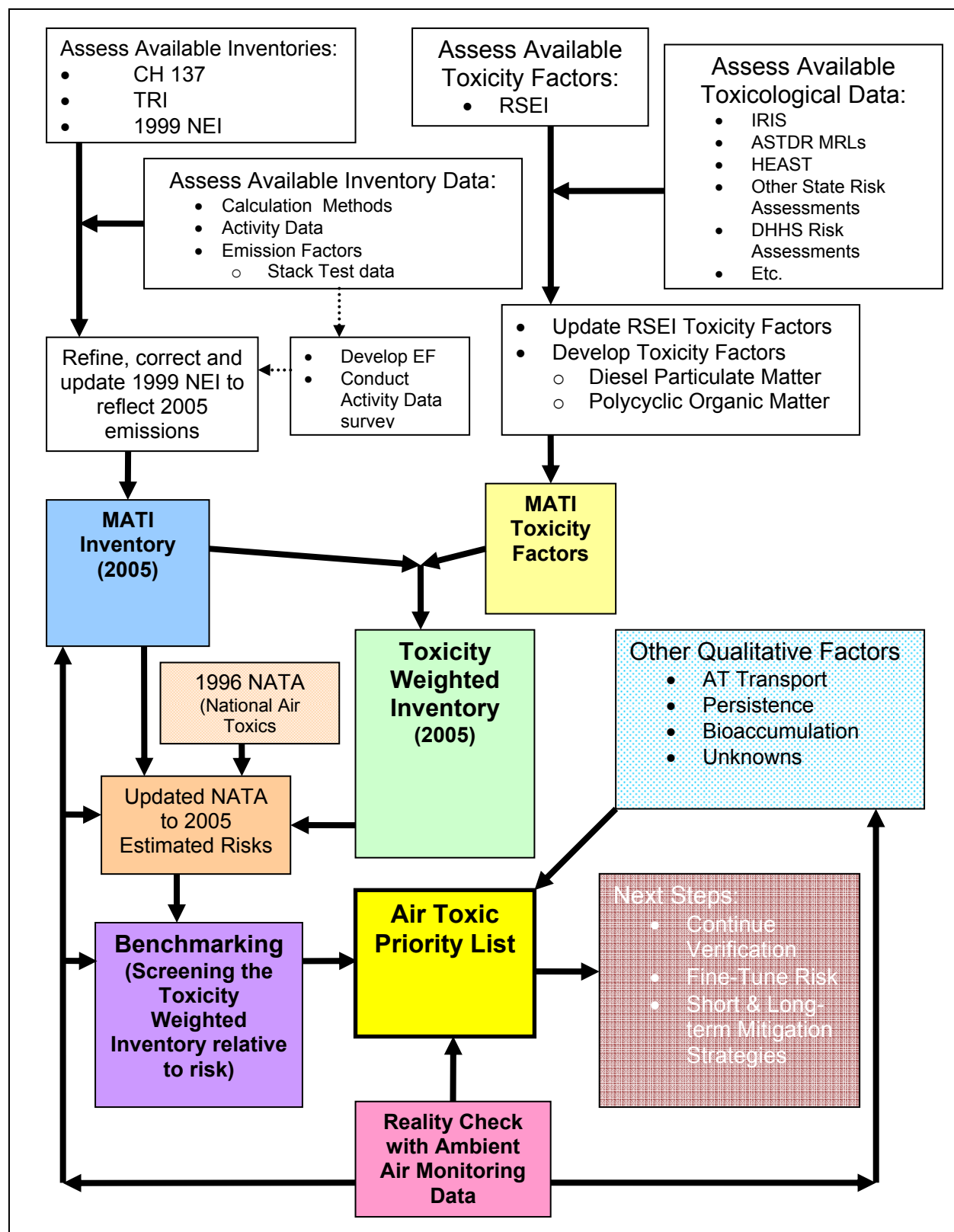
MEDEP defines the Incremental Lifetime Cancer Risk (ILCR) as the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a chemical. ILCR is estimated by multiplying the Average Daily Dose over a lifetime by the Cancer Potency Factor.⁵

Not all exposures above the non-cancer threshold are equal from a toxicological perspective. Some RfDs and RfCs protect against overt toxicity, while others protect against subtle physiological changes that may signal the onset of toxicity. Some RfDs/RfCs incorporate large uncertainty factors (1,000-fold or more) while others incorporate very small uncertainty factors (less than 10). These uncertainty factors give a measure of the strength of the toxicological data underlying a toxicity value: the larger

Figure 6: Detailed Steps in Developing Maine’s Air Toxics Priority List

⁴ The default factor for the number of years that a person is exposed to the pollutants in the air (Exposure duration) is 30 years.

⁵ For more information on deriving HI and ILCR, see Chapter 5 of MEDEP and MEDHHS, “Guidance Manual for Human Health Risk Assessments at Hazardous Substance Sites”, June 1994 (Hank Aho, BRWM-MEDEP, 17 SHS, Augusta, ME 04333-0017; 207-287-2651).



the uncertainty factor, the weaker the available data. Similarly, one must be aware that the uncertainty in predicted cancer risks associated with a “known human carcinogen” may be smaller than that associated with a “probable” or “possible” human carcinogen.

Finally, it is important to note that children, pregnant women and those with existing health problems are more susceptible to health impacts from a given exposure concentration than the general population.

2.2.2 Acceptable Risk

Acceptable Risk is established by policy. An agency's acceptable risk will vary in different circumstances. Often a more stringent "acceptable risk" level is used on screening risk assessments, as compared to a more detailed risk assessment. Risk managers will vary the acceptable risk based on the feasibility or cost of achieving a given risk level. Generally, MEDHHS defines acceptable risks as risks below a Health Quotient (HI) of 1 and below an Incremental Lifetime Cancer Risk (ILCR) of one in a one hundred thousand across all media and pollutants⁶. USEPA air programs have historically defined acceptable risks as risks below a HI of 1 (non-carcinogens), and an ILCR of between one in one million and one in ten thousand (carcinogens). In the early 1990's the Maine legislature established Ambient Air Standards for Toluene at a HI of 1, and for Perchloroethylene at an ILCR of 1 in a million. The MEDEP Air Bureau has adopted federal programs to control AT emissions, and therefore defines "acceptable risks" as risks below a HI of 1, and for carcinogens uses a risk range of an ILCR of between one in one million and one in ten thousand.

Table 1: "Acceptable Risk" Levels for MEDEP, MEDHHS and USEPA

Agency	Acceptable Carcinogenic Risk (Incremental Lifetime Cancer Risk)	Acceptable Non-carcinogenic risk (Hazard Index)
Maine Department of Health and Human Services	ILCR < 1 in 100,000	HI < 1
US Environmental Protection Agency	ILCR < between 1 in a million and one in 10 thousand	HI < 1
Maine Department of Environmental Protection, Bureau of Air Quality	ILCR < 1 between 1 in a million and one in 10 thousand	HI < 1

This document often compares monitoring results to the DHHS's Maine Ambient Air Guidelines (MAAG). These guidelines were most recently revised in April of 2004, at which time MAAGs were established at the equivalent of a HI of 1, and an ILCR of one in 100,000. As stated in the basis statement for the guidelines:

The Maine Bureau of Health's (BOH) Environmental Health Unit develops Ambient Air Guidelines (AAGs) to assist risk managers and the public in making decisions regarding the potential human health hazards associated with chemicals in air. AAGs are not promulgated by rule making and therefore are not issued as legally enforceable ambient air "standards." Rather, AAGs represent the Bureau's most recent recommendations for chemical concentrations in

⁶ "Guidance Manual for Human Health Risk Assessments at Hazardous Substance Sites", June 1994 (Hank Aho, BRWM-MEDEP, 17 SHS, Augusta, ME 04333-0017; 207-287-2651).

ambient air, below which there is minimal risk of a deleterious health effect resulting from long term inhalation exposure.

The AAGs are intended to be solely health-based guidelines, and do not take into account analytical methods, treatment technology, or economic impacts...

[The latest guideline] revision focuses exclusively on AAGs for effects due to chronic exposure ("chronic" refers to long-term exposure). Chronic AAGs represent long-term average air concentrations. Thus, chronic AAGs are most appropriately compared with long-term average air measurements (e.g., yearly averages). As a screening measure, it is conservative (i.e., health-protective) to compare chronic AAGs with short-term measurements...⁷

3. DEVELOPMENT OF MATI EMISSIONS INVENTORY

The inventory subcommittee developed a complete HAPs inventory for the MATI process, including emission estimations for Point Sources, Area, and Mobile source sectors. This inventory was developed using protocols developed by USEPA and MEDEP as discussed in detail below.

3.1 An Introduction to Air Emission Inventories

MEDEP and EPA have standard protocols to estimate the amount of pollutants that are released to the air. Estimations are usually made by multiplying "activity data", such as gallons of fuel burned, times an "emission factor", such as pounds of pollutant released per gallon of fuel burned. By convention, air emission inventories are often broken down into four major categories: Point Sources, Area Sources, Mobile Sources, and Biogenic Sources. These categories are described in more detail below.

3.1.1 Point Sources and Major Sources

"Point Sources" is a category comprised of facilities that emit pollutants above a certain threshold, from a stack, vent or similar discrete point of release. The threshold varies between inventories. Federal rules usually establish the threshold at 10 tons per year of a single Hazardous Air Pollutant, or 25 tons of a mixture of HAPs. Point sources releasing pollutants above the Federal Threshold are termed "Major Sources". Under MEDEP Regulations, Chapter 137, "Emission Statements", stationary sources emitting more than 1 ton of any one of a listed HAP, or 0.1 ton of other specified HAPs, must report Estimates of Point Source releases. The state inventory is derived from summing the releases from each facility that reports. Each facility may estimate their pollutant release either from direct measurement, or based on standard estimation techniques for the relevant process at the facility.

3.1.2 Area Sources and Non-Point Sources

"Area sources" are sources of air pollutants that are diffused over a wide geographical area or are estimated in the aggregate. Area sources include emissions from

⁷ Maine Bureau of Health Ambient Air Guidelines, April, 2004, Prepared by: Environmental Health Unit Bureau of Health Department of Health and Human Services (11 SHS, Augusta, ME 04333-0011) <http://www.maine.gov/dhhs/ehu/air/AAGProc.pdf>.

smokestacks, vents or other Point Sources, that in and of themselves are insignificant, but in aggregate may comprise significant emissions. An example would be emissions from small dry cleaners or home heating boilers. Area sources also comprise emissions that do not come from a specific Point Source, such as ATs volatilizing from house painting, chainsaws or lawnmowers. Estimations of pollutant losses for many subcategories are made using standard techniques, often based on emissions per capita or per employee.

For inventory purposes, Area Sources are sometimes also called “Non-point Sources”. This is because in air regulations, Area Sources also refers to sectors of facilities that are smaller than Major Sources, but are still subject to NESHAPs, and the use of the same term in the same program can cause confusion. Non-Point Sources is also the term that is used for facilities that discharge water pollutants to a waterbody from over-land flow, rather than a pipe.

3.1.3 Mobile Sources

“Mobile sources” are sources of air pollution from internal combustion engines used to propel cars, trucks, trains, buses, airplanes, ATV’s, snowmobiles, etc. Mobile source inventories are often further broken down into on-road vehicles, and off-road vehicles. EPA has published models that are used to estimate releases of pollutants from these categories.

3.1.4 Background and Biogenic Sources

Background means the concentrations of Air Toxics that are from natural sources (also called “Biogenic Sources”) and man-made pollutants that are either still in the air from previous years emissions, or have been emitted outside the inventory area and then transported into the region. MEDEP depends on EPA to run models that determine releases from the natural sources. Likewise, an assessment of a chemical’s properties and complex air models are used to determine contributions from out-side the state, or from previous emission years. A fuller discussion of how EPA handled background concentrations in the NATA is included on the EPA’s Air Toxics website at: <http://www.epa.gov/ttn/atw/nata/>.

3.1.5 Uncertainty in Emission Estimates

Uncertainty in emission estimates stems from three main areas: Uncertainty in calculation methods, activity data, and emission factors.

3.1.5.1 Calculation Methods

ATAC’s Inventory Subcommittee used established EPA protocols in using emission factors and calculating emissions. These protocols are described on EPA’s Air Chief website, which can be accessed at: <http://www.epa.gov/ttn/chief/index.html>. Generally EPA has a preferred method which will generate the most accurate emission estimates. Alternative methods are also developed because often the data necessary for the preferred method may not be available. Use of alternative methods will increase the uncertainty of

emission estimates. The ATAC reviewed emissions from source categories that created the greatest risk, available estimation methodologies, and available data. The ATAC the assessed it's resources for revising and updating emission estimates, and focused efforts on developing emissions using the methodology that would introduce the least uncertainty in the over-all toxicity-weighted inventory.

3.1.5.2 Activity Data

There may be varying degrees of uncertainty in measurement of "activity data", such as population or fuel use. EPA and MEDEP attempt to obtain the most recent and accurate activity data for use in inventories. There is a trade-off between the two goals because it takes some time to compile and review the data for accuracy. To compensate, current activity data is sometimes projected from older data. The projections insert more uncertainty into the process, but helps account for changes in actual emissions since compilation of the latest inventory. Additionally, there will be varying sources of information. EPA and MEDEP try to obtain the most accurate data possible. However, the most accurate data does not always cover the area needed. For instance, in some cases only state-wide data is available. If more localized information is needed, say on the county level, the state-wide number must be apportioned down to the county level, based on population or some other relevant surrogate that is known on the county level.

3.1.5.3 Emission Factors

There is also uncertainty inherent in using emission factors. Emission factors are most accurate for the individual stack and equipment that they were developed for, and when there have been several tests to confirm representative operating conditions. Emission factors from one process or facility are often applied to a similar facility, which introduces a higher level of uncertainty. Emission factors for Area Sources are usually based on standard emission factors. For Point sources, the emission factors diminish in accuracy when descending down the following sources of information:

1. Emission estimates based on Continuous Emission Monitoring Systems (CEMS);
2. Recent periodic monitoring of emissions (such as stack tests) under representative operating conditions;
3. Emission estimates based on a facility-specific emission factor developed in accordance with standard procedures; and
4. Standard emission factors applicable to the source published by EPA or trade organizations

Additionally, if analytical data is not available, then an emission factor can not be developed, so the inventory cannot include emissions from that process or for that parameter. For example, there is no acrolein emission factor for residential wood-stoves, although this source is often described as a big producer of acrolein.

EPA and MEDEP attempt to increase accuracy and decrease uncertainty of emission estimates for the sources that have the greatest impact in terms of toxicity-weighted emissions. Point source estimates for an individual facility are generally the most accurate, especially for the larger facilities. However, as discussed in section 4.6, on page 48, one major area of uncertainty with this assessment is the emission factor for acrolein from wood-fired boilers.

3.2 Review of Available Air Emissions Inventories

The ATAC had access to more information on emissions from Point Sources, as compared to Area Sources and Mobile sources. Each inventory will vary as to the number of facilities reporting in the Point Source category, the number of Air Toxics covered, the number of source categories covered, and the most recent data compiled. The ATAC assessed each of the following inventories when deriving the MATI emissions inventory.

3.2.1 National Emissions Inventory

The National Emissions Inventory (NEI)⁸ is a national database of air emissions information that is compiled by EPA. The NEI contains information on releases of the 188 federal Hazardous Air Pollutants from Point, Area, and Mobile sources for 1996 and 1999. EPA developed the database “for air dispersion modeling, regional strategy development, regulation setting, air toxics risk assessment, and tracking trends in emissions over time... The EPA compiles the NEI HAP emission estimates from five primary sources:

1. State and local HAP inventories.
2. Existing databases related to EPA's Maximum Achievable Control Technology (MACT) programs to reduce HAP emissions.
3. Toxic Release Inventory (TRI) data (www.epa.gov/tri/)
4. Emissions estimated by using Mobile source methodology developed by EPA's Office of Transportation and Air Quality (OTAQ).
5. Stationary non-Point Source emission estimates generated using emission factors and activity data.”⁹

The 1996 NEI was used as the emissions input data for the National Air Toxics Assessment, which is described 3.2.2 below. More information on the NEI can be obtained from EPA's website at <http://www.epa.gov/ttn/chief/eiinformation.html>.

⁸ Before 1999, EPA maintained HAP emission estimates in the National Toxics Inventory (NTI) database.

⁹ Quoted from EPA's Air Chief Web Page, “What is the National Emissions Inventory (NEI)?” (<http://www.epa.gov/ttn/chief/net/neiwhatis.html>).

The strength of the NEI database is that it includes emission estimates from not only Point Sources, but also the Area and Mobile source categories. Other strengths are that the database includes all of the 188 federally listed HAPs, and recent documentation published by EPA clearly describes how the emission estimates were developed. The weakness of this database is that the emission estimates represent 1999 estimates, and as discussed below, contained significant emission estimate errors. The ATAC inventory Subcommittee was able to build upon the 1999 NEI to develop a current inventory for the MATI process.

3.2.2 National Air Toxics Assessment (NATA)

EPA undertook the National-Scale Air Toxics Assessment (1996 NATA) to help determine which ambient air toxics potentially posed the greatest risk to public health. The assessment is based on emissions data for the year 1996. EPA estimated ambient air pollutant concentrations across the country, and assessed the possible effect on human health from these pollutants. The assessment looked at 32 common air toxics identified by the EPA's Integrated Urban Air Toxics Strategy, plus diesel particulate matter. These air toxics were chosen because they pose the greatest potential risks to public health in urban areas. The NATA consisted of the following 4 steps, which are depicted in

Figure 7:

1. Determining what pollutants are released to the air. EPA used the 1996 National Emissions Inventory of air toxics emissions from outdoor sources, on a county by county basis, across the contiguous United States;
2. Estimating the concentrations of air toxics in the ambient air, in each county in the country. To do this EPA used the model called Assessment System for Population Exposure Nationwide (ASPEN);
3. Estimating the population exposure in each county to this air. To do this, EPA used the model called the Hazardous Air Pollutant Exposure Model, Version 4 (HAPEM4); and
4. Determine the potential public health risk due to inhalation of air toxics on a county by county basis. EPA used standard risk assessment protocols when assessing the risk, such as the protocols that have been developed for the Superfund program.

The compounds that EPA examined in the NATA, are included in Table 2. More information on NATA, each of the above steps, and the chemical listed below, is available from EPA's air toxics website at: <http://www.epa.gov/ttn/atw/nata/>.

The advantage of the NATA data is that both emission mass and potential risk to human health posed by the emission are presented. Additionally, the information is graphically displayed for easy review. Also NATA assesses the Area and Mobile source categories, in addition to the Point Sources. Finally, the information is readily available on the Internet. One disadvantage of the NATA data is that it only covers 33

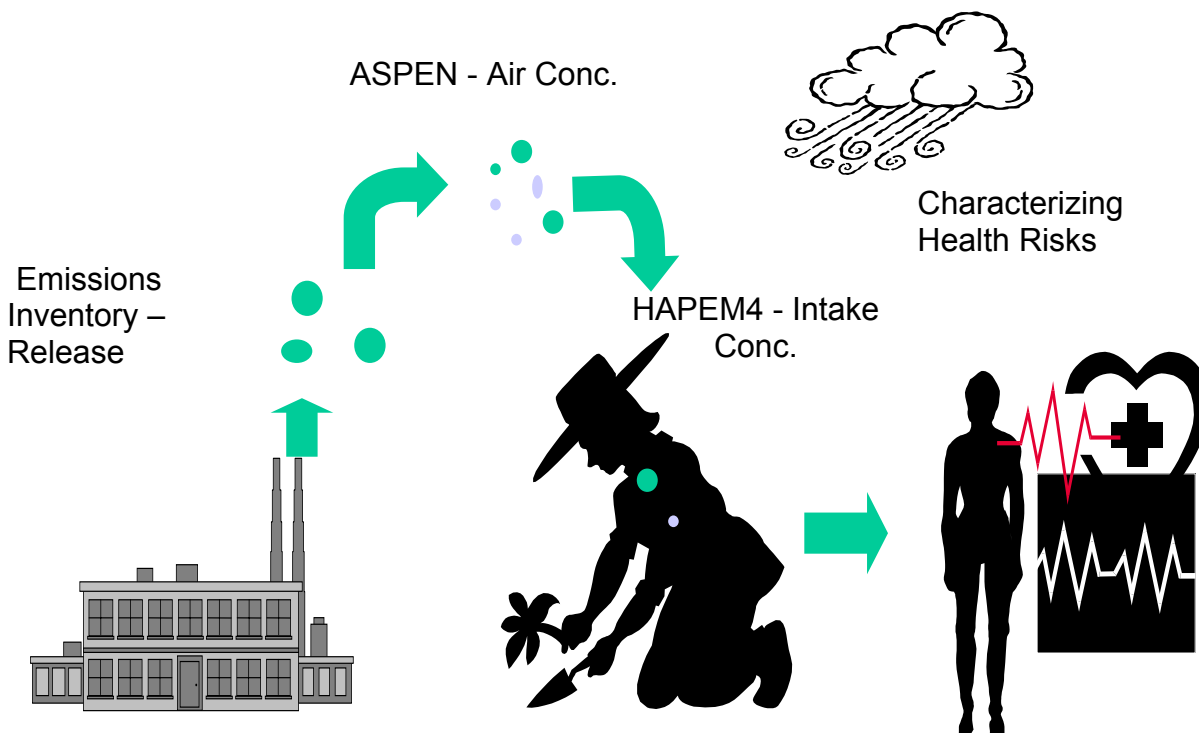
compounds¹⁰. However, these compounds were selected based on their potential to adversely impact health, consistent with Maine's proposed approach. Another drawback is that the assessment is based on 1996 emissions data, although a version based on 1999 data is scheduled for release later this year. The 1996 data is old and incomplete.

Table 2 The 33 Compounds Assessed in EPA's National-Scale Air Toxics Assessment

1. acetaldehyde	18. formaldehyde
2. acrolein	19. hexachlorobenzene
3. acrylonitrile	20. hydrazine
4. arsenic compounds	21. lead compounds
5. benzene	22. manganese compounds
6. beryllium compounds	23. mercury compounds
7. 1, 3-butadiene	24. methylene chloride
8. cadmium compounds	25. nickel compounds
9. carbon tetrachloride	26. perchloroethylene (Tetrachloroethylene)
10. chloroform	27. polychlorinated biphenyls (PCBs)
11. chromium compounds	28. polycyclic organic matter (POM)*
12. coke oven emissions	29. propylene dichloride
13. 1, 3-dichloropropene	30. quinoline
14. diesel particulate matter	31. 1, 1, 2, 2-tetrachloroethane
15. ethylene dibromide	32. trichloroethylene
16. ethylene dichloride	33. vinyl chloride
17. ethylene oxide	* also represented as <u>7-PAH</u>

¹⁰ The 1996 NATA calculated the risk from 31 pollutants, and qualitatively described the risk posed by two others, for which Carcinogenic Potency Factors or Reference Doses were not available in order to undertake the calculations.

Figure 7: Schematic of National Air Toxics Assessment



3.2.3 Chapter 137 Inventory

Under MEDEP regulations Chapter 137, “Emission Statements”, individual facilities that emit any of 217 pollutants above certain thresholds must report these releases to MEDEP every three years¹¹. This information is entered into the MEDEP’s Chapter 137 Point Source HAP database. The database contains information for sporadic years, dating back to 1993. More information on the Chapter 137 Inventory is available from <http://www.state.me.us/dep/air/>.

The strength of the Chapter 137 database is that MEDEP is able to perform its own quality control checks to ensure the accuracy of the information. Additionally, reporting thresholds under Chapter 137 are lower than those required under Federal Toxics Release Inventory rules (see Section 3.2.4 below), so the Chapter 137 HAP database contains information from more facilities than the TRI database. Finally, the 2002 inventory data is the most current of all the databases reviewed. The weakness of the database is that it does not include emission information on Area or Mobile source categories. Further, data regarding HAPs from combustion have been inconsistently collected.

¹¹ Prior to 2002, the Chapter 137 Point HAP inventory was collected every 2 years. The Department revised Maine Regulations to require reporting of Air Toxics on a 3 year cycle, to coincide with EPA’s inventory cycle for Hazardous Air Pollutants.

3.2.4 Toxics Release Inventory

The Pollution Prevention Act of 1990 requires certain classes of companies that also employ more than 10 people, and that discharge one of 650 pollutants to the air, water, or land above certain thresholds, to report this information annually to the state and federal governments¹². The EPA inputs this data into the Toxics Release Inventory (TRI) database, which has data dating back to 1988. More information on TRI is available from <http://www.epa.gov/enviro/html/tris/>. The TRI data for the year 2002 that was considered by the ATAC's Inventory Subcommittee while developing the Air Toxics Priority List is available at EPA's Toxics Release Website at: <http://www.epa.gov/tri/>.

The strength of the TRI database is that the information is compiled annually, is current, covers the most compounds of any other database, and is readily accessible on the Internet. The weakness of this database is that it only covers discharges from select Point Sources, and not Area or Mobile sources. Additionally, the reporting thresholds are higher under TRI than Chapter 137, and are only applicable to select categories of facilities that also employ over 10 people. Further, emissions are often reported in a range, rather than as a specific value. Finally, dioxin isomers are not specified, so that it is impossible to assign toxicity values to dioxin (see section 3.4.1). Therefore, even though TRI covers more compounds, the TRI inventory does not contain as much useful information on Maine emissions as does Chapter 137.

3.3 Development of MATI Inventory

The ATAC determined that the available inventories described in section 3.2 above were insufficient for development of the ATPL. Therefore, the subcommittee developed a complete HAP inventory, as described in this section. Further details on the specific calculations undertaken by the MATI inventory subcommittee are available on the MEDEP's MATI website at: <http://www.maine.gov/dep/air/toxics/mati.htm>

3.3.1 MATI Point Source Inventory

For Point Sources, the inventory subcommittee reviewed the emission estimates for all of the facilities that were included in three separate Point Source inventories for HAPs, which are described in detail in section 3.2 above:

- the 1999 NEI, Version 3.0;
- the 2002 Chapter 137 HAP Inventory; and
- the 2002 TRI inventory.

The information in these inventories was carefully reviewed in conjunction with information in MEDEP's license files, and fuel combustion data in the MEDEP's i-STEPS database¹³. Discrepancies were reviewed with MEDEP licensing engineers, and with

¹² This information must be submitted pursuant to the requirements of the federal Emergency Planning and Community Right-to-Know Act of 1986 (EPCRA), as expanded by the Pollution Prevention Act of 1990.

¹³ i-STEPS is the database which houses the MEDEP's Point Source Inventory for Criteria Pollutants. This database contains the fuel used by each facility that has reported its criteria pollutant emissions

the facility personnel responsible for emission inventories. The inventory subcommittee reviewed in greater detail those facilities with the highest Toxicity-Weighted emissions, and facilities that had differing HAP emissions as compared to similar facilities. The emissions from the largest facilities (based on toxicity-weighting) were based on the most recent activity data, in most cases 2003. Finally, the Point Source list was updated to account for facility closures through the end of 2004.

The final Point Source inventory is included on the MEDEP's MATI Website at: <http://www.maine.gov/dep/air/toxics/mati-docs.htm>.

3.3.1.1 Air Toxics from Fuel Combustion

Combustion of fuel results in a significant release of air toxics in Maine, but these emissions have been inconsistently reported under Chapter 137. The Inventory Subcommittee estimated HAP emissions as follows:

1. **Emission Factors:** The Inventory Subcommittee has extracted emission factors for combustion of fuel by the industrial & electric sectors from FIRE 6.25¹⁴. FIRE is the database that houses the currently recommended emission factors for inventory purposes. No revoked EFs were used.
 - A. **Missing EF's for a SCC unit:** Emission factors are stored by SCC code. Likewise, fuel combustion reported under Ch 137 to MEDEP is reported by SCC unit. In many instances, a given SCC did not have HAP emission factors. In these cases, emission factors for SCCs burning similar fuels were used. In cases where multiple EF for a given pollutant existed for a fuel type, the following hierarchy was used:
 - (1) The EF having the higher confidence rating for a given fuel category was used.
 - (2) EFs relating to the most common SCC for a given fuel type were used.
 - (3) EFs with the most recent citation were used.

under Chapter 137. The MEDEP's reporting thresholds are lower than the EPA's thresholds, so that the database contains all of the fuel use by over 200 of the largest industrial facilities in the state.

¹⁴ From EPA's Factor Information REtrieval (FIRE) Website at:

<http://www.epa.gov/ttn/chief/software/fire/index.html>, "The Factor Information REtrieval (FIRE) Data System is a database containing EPA's emission estimation factors for criteria and hazardous air pollutants in an easy to use Windows program. Users can browse through records in the database or select specific emissions factors by source category, source classification code (SCC), pollutant name, CAS number, or control device. FIRE 6.25 contains emissions factors from the [Compilation Of Air Pollutant Emission Factors \(AP-42 Fifth Edition\)](#) for all AP42 sections posted by September 1, 2004, the [Locating and Estimating \(L&E\) series](#) of documents, and the retired AFSEF and XATEF documents."

- B. **Control Efficiency:** Emission Factors in FIRE often are based on no emission controls, while the Point Sources in Maine generally have pollution control devices. The Inventory Subcommittee estimated removal of metals by pollution control devices (Control Efficiency) as follows:
 - (1) Where an emission factor was developed based on emissions from facilities with emission controls, no additional control was applied.
 - (2) Control Efficiency for metals was assumed to be 90%, except for mercury which was assumed to have a control efficiency of 70%.
 - (3) Organics were assumed to have zero control efficiency.
 - C. **Ranges:** Emission factors in FIRE are sometimes reported as a range. In these cases the the Inventory Subcommittee used the median value ($[\text{High value} + \text{Low value}]/2$).
 - D. **Non-Detects:** Emission factors in FIRE are sometimes reported as a “less than” value, presumably based on non-detect values. In these cases $\frac{1}{2}$ of the “less than” value was used ($[\text{less-than-value}]/2$).
2. **Use of MACT Emission Factors.** In some cases, EPA has developed more recent emission factors to use in writing rules for the Maximum Available Control Technology (MACT) program. Specifically, EPA developed rules for the Boiler and Plywood MACT.
- A. **Boiler MACT:** Emission factors were developed for the recent Boiler MACT¹⁵ rule. However, scrutiny of the mercury and chlorine Emission Factors suggests that these two factors are inaccurate. Consequently, the inventory program at EPA does not recommend use of these Boiler MACT emission factors until that program has a chance to review the factors in more detail. Therefore, emission factors from the FIRE database were used for fuel combustion whenever possible. However, for several important combustion HAPs, emission factors were only available from the MACT rule development. Therefore, emission factors from the Boiler MACT had to be used. These Emission Factors are shown in Table 3.

¹⁵ ERG memo 10/2002, using Emission Factors for #2 Fuel Oil, No Controls: (October 2002 Memo from Christy Burlew and Roy Oommen, Eastern Research Group to Jim Eddinger, USEPA, ; Subject: Development of Average Emission Factors and Baseline Emission Estimates for the Industrial, Commercial and Institutional Boilers and Process Heaters NESHAP.)

Table 3: Boiler MACT Emission Factors Used in the MATI Inventory

Fuel:	Distillate	Residual	Wood
Pollutant	Emission Factor (LB/1,000 gal)	Emission Factor (LB/1,000 gal)	Emission Factor (LB/Ton)
ACROLEIN	1.39E-03	1.49E-03	(FIRE factor available)
ETHYL BENZENE	4.52E-05	4.85E-05	(FIRE factor available)
HYDROCHLORIC ACID (acid aerosol only)	9.94E-03	1.07E-02	1.323E-01
METHYL CHLORIDE	4.21E-03	4.52E-03	(FIRE factor available)
PHOSPHORUS	2.55E-02	2.73E-02	(FIRE factor available)
1,1,1-Trichloroethane	1.50E-04	1.61E-04	(FIRE factor available)
TOLUENE	8.75E-04	5.93E-03	2.11E-04
XYLENES (ISOMERS & MIXTURE)	6.34E-04	1.68E-01	5.59E-05

- B. **Plywood MACT:** EPA recently developed emission factors as part of the Plywood MACT rule development. These emission factors were based, in part, on stack test data from Maine's Oriented Strand Board (OSB) facilities. Stack test data specific for Maine's OSB facilities, as contained in the MACT Plywood docket, and the most recent throughputs were used to develop current emission estimates from the two Maine facilities. However, during the Point Source review, the two Maine facilities had more recent stack test data, so emission estimates were revised to reflect the most recent stack-tests and throughput information.
3. **Chromium Speciation:** In most cases, for fuel combustion, a Cr⁺⁶ emission factor was available so it was used. In cases where a hexavalent chromium EF was not available, one was derived using the same protocols that EPA will use to speciate total chromium in the 1999 NATA. The 1999 NATA default chromium speciation factors are available on the MATI website:
<http://www.maine.gov/dep/air/toxics/mati-docs.htm>.
4. **Fuel Combustion Activity Data:**
 - A. **Industrial & Utility Sector:** Formerly, the over-all data consumption for the industrial and utility sector was based on 2000 US Department of Energy (DOE) data. HAPs emissions from fuel combustion from the Industrial and Utility sector were revised using 2003 fuel use data supplied by Point Sources to MEDEP in compliance with the 06-096 CMR chapter 137 criteria pollutant inventory. The Chapter 137 data is stored in the MEDEP's i-STEPS database. The most recent fuel use data that has been reported to MEDEP and that has completed a quality assurance review is for emission year 2003.

- B. **Commercial and Residential Sector:** For the commercial and residential sector, DOE data was used, since the Inventory Subcommittee does not have other source of reliable information for fuel use in these sectors.

3.3.1.2 Pulp and Papermills.

In some cases, HAPs are missing from inventories supplied by Pulp and Paper plants. To ensure consistency and an accurate inventory, MEDEP filled these holes using the following hierarchy:

1. **Mill Estimates:** Provided they passed a MEDEP quality review, Mill estimates for given pollutants were used when provided to MEDEP as part of the 2002 Chapter 137 submission, or during subsequent reviews.
2. **NCASI EFs:** Missing pollutants for a given mill were estimated by MEDEP based upon NCASI emission factors that are available to MEDEP.
3. **FIRE EFs:** When NCASI emission factors were not available, emission factors relating to any missing combustion HAPs were extracted from the FIRE database, as described in section 3.3.1.1 above.
4. **MACT EF:** As a last resort, if any combustion HAPs were still missing, the Utility MACT emission factors were used to estimate emissions.

3.3.1.3 Chromium.

Hexavalent chromium (Cr^{+6}) is much more toxic than trivalent chromium (Cr^{+3}). Total Chromium was speciated using SCC specific emission factors from FIRE as described in section 3.3.1.1 above. When emission factors were not available, a chromium emission factor was derived on an SCC basis, using the protocols being used by EPA in the 1999 NATA.

3.3.1.4 Inventory of Fugitive Emissions of HAPs from Municipal Waste Combustor Tipping Floors

Emission estimates for HAPs from the state's four Municipal Waste Combustors were supplemented to include estimates of fugitive emissions from the degradation of solid waste on each facility's tipping floor. Fugitive emissions from the state's four Municipal Waste Combustors (MWCs) were not reported in the Point HAP inventories. At least one of the four MWCs now operating in Maine vents some of the air from the tipping floor to a seasonally operated odor scrubbing unit on the facility's roof, and then to the atmosphere. In 2003 that facility, Maine Energy Recovery Facility

(MERC), sampled this off-gas for select HAPs. Based on these analytical results, the ATAC calculated emissions from the MERC facility. The ATAC then apportioned tipping floor HAPs to the other 3 MWCs in the state, based on throughput of solid waste.

3.3.2 MATI Area Source Inventory

For Area Sources, the inventory subcommittee reviewed the 1999 NEI, and determined which sources were significant based on a toxicity-weighted emissions (see section 4 on page 42). The subcommittee then reviewed the methodology and activity data that was used to derive the estimate. The subcommittee updated each category in which the 1999 NEI did not represent current emissions. The subcommittee used the most recent inventory method that was available, as published by EPA for the 1999 or preliminary 2002 NEI¹⁶, and the most current available activity data.

The Area Source estimations for the 1999 National Emissions Inventory (NEI) version 3.0 were developed using standard EPA estimation methods. Typically, several alternative methods are available to estimate source categories, using differing data inputs and formulas, which result in differing degrees of precision. The method employed largely depends on the available input data; if data is available for a more precise estimation alternative, that alternative is employed. The accuracy and uncertainty of an emission estimate is dependent on the accuracy and uncertainty of the activity data, emission factors, and formulas used to derive the estimation.

The subcommittee identified several significant errors with the 1999 NEI for Maine, and corrected them. For example, HAP emissions from forest and other wildfires represented significant toxicity-weighted emissions. EPA had generated these emissions based on an erroneously high count of forest fires in Maine, and high fuel combustion rates per acre. MEDEP had attempted to correct these errors in the 1999 NEI, but the forest fire emissions developed by the state were mis-coded in the NEI. Therefore the inventory contained not only EPA's inflated HAP emissions for wildfires, but also the correct emissions under a different category label. Likewise, high chromium emissions were attributed to polyurethane foam production due to a likely coding error. These and similar errors were corrected for the MATI inventory.

The subcommittee also reviewed the activity data that was used to derive the 1999 NEI. The subcommittee updated HAP emissions from residential, commercial, and

¹⁶ "Documentation for the Final 1999 Nonpoint Area Source National Emissions Inventory for Hazardous Air Pollutants (Version 3.0)" And "Documentation for the 2002 Nonpoint source National Emissions Inventory (NEI) for Criteria and Hazardous Air Pollutants: January 2004 Version." March 30, 2004, (Emission Factor and Inventory Group (D205-01), Emissions, Monitoring and Analysis Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, NC 27711). (<http://www.epa.gov/ttn/chief/net/1999inventory.html>)

industrial¹⁷ fuel combustion based on the most recent available energy consumption values published for Maine by the US Department of Energy.

The subcommittee made sure that the inventory included emission estimates of the specific HAPs for each sector of the fuel burning categories. To do this, emission factors for POM, Naphthalene and Dioxins applicable to the Residential Wood Burning source category were also applied to the Commercial/Institutional wood burning category, since there were not emission factors for the latter category (see Table 4). Likewise, emission factors for chlorine and acrolein developed for Commercial/Institutional Wood Combustion were applied to Residential Wood Combustion, because residential did not have emission factors. While these estimates are highly uncertain, they more likely represent the real emission from wood combustion than zero.

Table 4: MATI Inventory Before Substituting Similar Source Emission Factors for Wood Combustion

Pollutant	Toxicity-Weighted Emissions from Wood Combustion		
	Commercial/Institutional	Residential	Total Toxicity Score
Total	144,251,793	709,315,080	853,566,873
POM	0	584,204,982	584,204,982
Chromium	73,741,560	4,242,552	77,984,112
Naphthalene	0	63,448,000	63,448,000
Benzene	74,755	34,955,200	35,029,955
Manganese	20,660,760	2,007,720	22,668,480
Lead	1,800,656	15,632,144	17,432,800
Chlorine	14,469,570	0	14,469,570
Hydrochloric Acid	12,891,091	202,068	13,093,159
Acrolein	8,304,300	0	8,304,300
Nickel	5,366,880	151,765	5,518,645
Cadmium	3,104,100	638,100	3,742,200
Formaldehyde	1,753,890	1,410,960	3,164,850
Arsenic	1,513,420	813,068	2,326,488
Toluene	1,026	1,057,905	1,058,931
Mercury	254,880	9,630	264,510
Beryllium	260,100	0	260,100
Dioxins	3	174,909	174,911
o-Xylene	443	169,260	169,703

The subcommittee also revised HAP emissions attributed to the illegal burning of Municipal Solid Waste in Maine. Emissions were based on information generated for Maine by the State's fire wardens concerning the number of barrels formerly used in Maine, a ban on the practice, and an assumption of 20% non-compliance with the ban.

¹⁷ The industrial fuel combustion was primarily included in the Point inventory. Incidental amounts of fuel were estimated to have been burned in the state when the Point fuel combustion values attributable to individual Point Sources (from MEDEP's i-STEPS database) were subtracted from the state-wide fuel consumption estimated by the US Department of Energy.

The subcommittee also evaluated emission estimates that were calculated by EPA based on information that it obtained while developing Maximum Available Control Technology (MACT) standards. Some of the Maine emission estimates from MACT sources were based on outdated activity data. Updated activity data from manufactures directories were used to update these calculations. However, the MACT inventory often contained emission factors that were more recent, and could be applied to specific source categories.

Dry cleaner emissions were derived from registration and reporting information for perchloroethylene dry cleaners in Maine. Emissions from every dry cleaner in the state are reported to MEDEP, in accordance with Department Regulations 06-096 CMR Chapter 125.

The inventory subcommittee also attempted to develop emission inventories for source categories that could have significant HAP emissions, but that were not included in the NEI. However, these efforts were to no avail, since the NEI covered all source areas that there were emission factors for. For example, the subcommittee attempted to develop an emission inventory for co-planer PCBs. PCBs can form in combustion processes in the presence of chlorine. Co-planer PCBs are a subset of PCBs that have dioxin like health impacts, and thus are much more toxic than other forms of PCBs. The MEDEP tried to obtain emission factors for co-planer PCBs through scientific journal and Internet searches. Only one journal article¹⁸ was found dealing with emission factors that included co-planner PCBs. The sources identified were not found in Maine, or not descriptive enough to attribute to Maine sources¹⁹.

3.3.3 MATI Mobile Source Inventory

For Mobile sources, MEDEP ran the latest Mobile emission factor model, Mobile 6.2, to develop current emission factors. These emission factors were then applied to Vehicle Miles Traveled for inventory year 2002. For off-road vehicles, MEDEP ran NONROAD2004, EPA's most current model for this sector. Further details of emission model runs can be found in MEDEP's Narrative for the Preliminary 2002 NEI²⁰.

Emissions from Trains, Commercial Marine Vessels, and Airplanes are not included in EPA models. Emissions from these Mobile sources are developed in a manner similar to the way Area Sources are developed. For the MATI inventory, the emission estimates for these mobile sectors were brought forward from the 1999 NEI version 3.0.

¹⁸ Brodsky, Efim, S. et.al., PCB Emission in the Combustion Process, Proceedings from the Dioxin & Endocrine Disruptors International Conference in Boston, MA 2003.

¹⁹(undefined power plant, Non-ferrous metallurgy plant, undefined cement plant, aluminum plant calcinations furnace, and aluminum plant entry into electrostatic filter)

²⁰ MEDEP, Public Review Draft - Methodology Used to Prepare the State of Maine Preliminary 2002 Emissions Inventory (Maine DEP, BAQ, 17 SHS, Augusta, ME 04333-0017) (<http://www.maine.gov/dep/air/emissions/dep-air-info.htm>), January 20, 2005.

3.3.4 Comparison to Maine MEDEP's Mercury and Dioxin Inventories

Historically, MEDEP developed specialized inventories for mercury and dioxin in excel workbooks. The inventory subcommittee reviewed these inventories to ensure that the largest sources of these two pollutants were captured in this project. The subcommittee confirmed that the MATI inventory had dioxin values for Municipal Waste Combustors, Industrial wood burners, and the paper industry. Additionally, dioxin TEQ values were added to the MATI inventory for the residential home heating oil category, and the on-road Mobile sources category, since these categories did not have dioxin values, and the Maine inventory indicated that they should. The MATI inventory was also compared to Maine's mercury emission inventory. The subcommittee found that the major contributors in Maine's Mercury Inventory were included in the MATI inventory as mercury sources. The subcommittee reviewed the emission factor for mercury from the combustion of distillate fuel oil in commercial facilities, and updated this factor based on the best available data.²¹

3.3.5 Development of a Diesel PM_{2.5} Inventory

Diesel exhaust is a complex mixture of chemical constituents existing in either gas or fine particulate form. Because diesel exhaust results from the combustion of diesel fuel, its composition can vary depending upon engine type, operating conditions, and fuel composition. Gaseous constituents of diesel exhaust may include carbon monoxide, carbon dioxide, nitrogen compounds, sulfur compounds, and low molecular-weight hydrocarbons. Toxicologically significant compounds emitted in diesel exhaust include formaldehyde, acrolein, benzene, 1,3-butadiene, polycyclic aromatic hydrocarbons (PAHs)²², and nitro-substituted PAHs.

The particulate fraction of diesel exhaust (diesel particulate matter, or DPM) is often used as a surrogate for exposure to diesel exhaust. DPM particles are very small. According to the Tenth Report on Carcinogens²³, approximately 98% of DPM particles are less than 10 µm in diameter, 94% of DPM particles are less than 2.5 µm, and 92% are less than 1 µm in diameter. The small size of DPM particles has important implications for the toxicity of DPM; particles of this size are highly respirable and can be inhaled deep into the lungs. In addition, the small particle size results in large surface area to which organic compounds may adsorb.

Because of its size, DPM is a component of ambient particulate matter characterized as PM_{2.5} (particulate matter less than 2.5 µm in diameter)²⁴. USEPA estimates that, on a nationwide basis, DPM represents about 6% of total ambient PM_{2.5} concentrations.

²¹ For additional information, see the May 17, 2005 Memo from the Emissions Inventory Subcommittee to interested parties, Subject: Mercury Emission Factor for Distillate Oil Combustion for the MATI Inventory, which is available on the MATI document Archive Website: <http://www.maine.gov/dep/air/toxics/mati-docs.htm>

²² USEPA estimates that PAH and PAH derivatives represent only about 1% of DPM (USEPA 2002).

²³ NTP, 2002. Report on Carcinogens, Tenth Edition; U.S. Department of Health and Human Services, Public Health Service, National Toxicology Program, December.

²⁴ PM_{2.5} is regulated as a criteria pollutant, and the current standard for annual average concentration is 15 ug/m³.

Various estimates of DPM as a fraction of $PM_{2.5}$ have been made using different estimation methods. The results range from a low of 3% (in Rochester, NY) to a high of 36% (for urban Los Angeles, CA). Estimates for Manhattan, NY are even higher. In general, the fraction is higher for urban areas, consistent with the greater density of diesel-burning engines in urban areas.

Fine Particulate Matter ($PM_{2.5}$) from a variety of sources is inventoried by Maine MEDEP and USEPA. To compile an inventory of Diesel $PM_{2.5}$ for the Air Toxics Priority List (ATPL) inventory, the MEDEP used the 2002 preliminary National Emissions Inventory (NEI). MEDEP recommends this inventory since the preliminary 2002 NEI is the most recent inventory covering Maine, the inventory methodology is well documented, the data are generated using peer reviewed models, has undergone an EPA quality assurance review, and the information is available on the web. The disadvantage is that the inventory does not use some state specific inputs, and has not undergone a full quality assurance review by MEDEP. MEDEP also considered using the final 1999 NEI, version 3.0. The advantages of the 1999 NEI data is that it has undergone a full quality assurance check by both MEDEP and USEPA, and was developed based on state specific emissions assumptions, rather than national factors. However, since the 1999 data is over four years old, and vehicle miles traveled vary fairly considerably from year to year, the preliminary 2002 inventory is more accurate. Further, by using peer-reviewed models and undergoing internal quality assurance checks, the information in the preliminary 2002 NEI will be reliable. Therefore, the Inventory Subcommittee used the preliminary 2002 NEI inventory as a basis for the diesel $PM_{2.5}$ inventory for this project. From the preliminary 2002 NEI, MEDEP extracted the $PM_{2.5}$ emissions data that was attributed to Mobile sources, both on-road and off-road, that burned diesel fuel.

More information on the source of this data is available on EPA's Air Chief Website at: <http://www.epa.gov/ttn/chief/net/2002inventory.html>.

3.3.6 Inventory Quality Control

The subcommittee did several quality control checks. One was to make sure that HAP emissions were not included in more than one major source category. For example, MACT sources were included in the area inventory only when they were not already included in the Point inventory. Likewise, industrial fuel combustion contained in the Point Source inventory were subtracted from the Area Source inventory, to prevent double counting.

Emission factors were generally selected from the methodologies in the 1999 or preliminary 2002 NEI development documentation. For the most part, the emission factors in these documents are derived from AP-42, as revised in the FIRE database. AP-42 was developed by USEPA for emission inventories. These factors have varying degrees of certainty, and are ranked from A, representing the highest level, to F, representing the lowest level of certainty. In some cases, the NEI development documents use more recent emission factors that have been developed by USEPA for MACT regulation development, or to support specific emission inventory categories. The certainty associated with these emission factors is not uniformly determined.

However, they were generally developed by EPA because of the unsuitability of existing AP-42 factors.

The MATI inventory was developed by MEDEP in an ACCESS© database. The MEDEP provided the inventory subcommittee with data reports derived from the MATI inventory in order for the subcommittee to perform “real world” checks on the data.

3.4 Consolidation of Select Pollutants into Pollutant Groups

3.4.1 Dioxin and Furans

Dioxin and furans are a class of 205 halogenated aromatic hydrocarbons, which can have detrimental impacts on human health at very low concentrations²⁵. For risk analysis purposes, dioxin and furan concentrations are usually expressed in “dioxin equivalents” (dioxin TEQ), which is the summation of the dioxins' proportional toxicity to the most potent dioxin congener: 2,3,7,8 tetrachlorodibenzo-*p*-dioxin (2378 TCDD). TEQ is based on 17 specific 2,3,7,8 substituted isomers, which are the most toxic forms of Dioxin known to scientists. The NEI lists both dioxin expressed as TEQ, and specific isomers. The ATAC believed that it was appropriate to simplify the AT risk ranking process by consolidating all of the dioxin isomers into dioxin TEQ for the following reasons:

- The Dioxin TEQ emission information in the MATI inventory is the most complete – that is information is not available for all sources to the isomer level, rather it may only be calculated to the TEQ level;
- Dioxin isomers often are generated from the same processes, so that lumping does not thwart the intended use of the AT priority list; and
- There is a recognized method of consolidated the risks posed by the various isomers. Therefore, a toxicity factor was available for Dioxin TEQ.

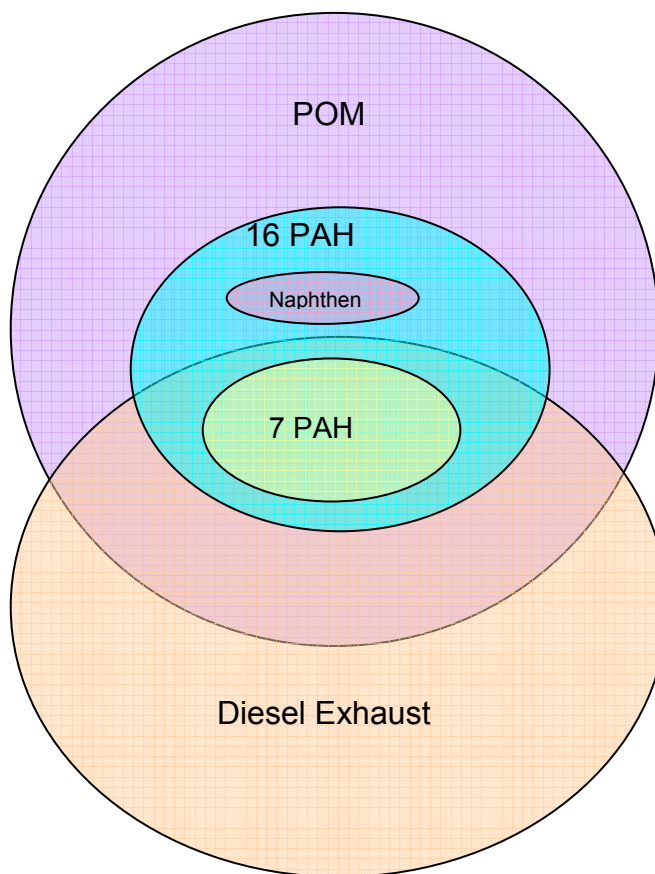
3.4.2 Polycyclic organic matter (POM)

Polycyclic organic matter (POM) is one of the federally listed Hazardous Air Pollutants. POM defines a broad class of compounds, “which generally includes all organic compounds with more than one benzene ring, and which have a boiling point greater than or equal to 212(F (100(C). Theoretically, millions of POM compounds could be formed. However, only a small portion of these compounds have actually been identified and regularly tested for as part of emissions tests.”²⁶

Figure 8: A Visual Representation of the Interrelated PAH & Diesel Exhaust groups

²⁵EPA, 1994, Estimating Exposure to Dioxin-Like Compounds, Volume II: Properties, Sources, Occurrence and Background Exposures (External review draft, EPA/600/6-8/005Cb) June.

²⁶ EPA, Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter (EPA-454/R-98-014, July 1998)



“POM compounds are formed primarily from combustion and are present in the atmosphere in particulate form. Sources of air emissions are diverse and include, vehicle exhausts, forest and wildfires, asphalt roads, coal, coal tar, coke ovens, agricultural burning, residential wood burning, and hazardous waste sites.”²⁷

POM includes the polycyclic aromatic hydrocarbon compounds (PAHs). Since it was not practical to analyze for all POM compounds, EPA developed monitoring protocols for 16-PAHs that could be used as surrogates for monitoring POM. This group of 16 PAHs included 7 that were probable human carcinogens. In the NATA, an assessment of the 16-PAHs was used to represent POM.²⁸ The compounds making up the 16 & 7 PAH groups are listed in Table 5.²⁹ In some instances, EPA removes Naphthene from the list of 16-PAHs. A visual depiction of the various POM groups, and their relationship to Diesel Exhaust, is shown in Figure 8.

²⁷ EPA's Air Toxics Website, NATA Homepage (<http://www.epa.gov/ttn/atw/nata/34poll.html>)

²⁸ EPA's Air Toxics Website, NATA Homepage (<http://www.epa.gov/ttn/atw/nata/34poll.html>)

²⁹ EPA, Locating and Estimating Air Emissions from Sources of Polycyclic Organic Matter (EPA-454/R-98-014, July 1998)

Table 5: Compounds Making up POM, PAHs and Diesel Exhaust, and Inventory and Monitoring Data Pertaining to These Groups

Compound	Included in Group				Included in Inventory		Included in ME Monitoring Prog
	Diesel Exhaust	POM	16-PAH	7-PAH	1999 NEI	1996 NATA	
16-PAH		X	X		X	X	
7-PAH		X	X		X	X	
All other POM		X					
Acenaphthene		X	X		X		
Anthracene		X	X		X		
Benz(a)anthracene*		X	X	X	X		
Benzo(a)pyrene*		X	X	X	X		
Benzo(b)fluoranthene*		X	X	X	X		
Benzo(ghi)perylene		X	X		X		
Benzo(k)fluoranthene*		X	X	X	X		
Chrysene*		X	X	X	X		
Dibenz(a,h)anthracene*		X	X	X	X		
Fluoranthene		X	X		X		
Fluorene		X	X		X		
Indeno(1,2,3-cd)pyrene*		X	X	X	X		
Naphthalene	X	X	X		X		
Phenanthrene		X	X		X		
Pyrene		X	X		X		
Total POM		X					
acetaldehyde	X				X	X	
acrolein	X				X	X	
Aniline	X				X		
antimony compounds	X				X		
arsenic	X				X	X	X
benzene	X				X	X	X
beryllium compounds	X				X	X	
biphenyl	X				X		
bis[2-ethylhexyl]phthalate	X				X		
Butadiene, 1,3-	X				X	X	
cadmium	X				X	X	
chlorine	X				X		
chlorobenzene	X				X		
chromium compounds	X				X	X	X
cobalt compounds	X				X		
cresol isomers	X				X		

Compound	Included in Group				Included in Inventory		Included in ME Monitoring Prog
	Diesel Exhaust	POM	16-PAH	7-PAH	1999 NEI	1996 NATA	
cyanide compounds	X				X		
dibutylphthalate	X						
Diesel PM _{2.5}	X						
dioxins and dibenzofurans	X						
ethyl benzene	X						
formaldehyde	X						
hexane	X						
Hydrocarbons	X						
inorganic lead	X					X	X
manganese compounds	X					X	X
mercury compounds	X					X	
methanol	X						
methyl ethyl ketone	X						X
m-xylenes	X						
nickel	X					X	X
Nitrobiphenyl, 4-	X						
o-xylenes	X						X
phenol	X						
phosphorus	X						
propionaldehyde	X						
p-xylenes	X						
selenium compounds	X						
styrene	X						
toluene	X						X
Total Diesel Exhaust	X					X	
xylene isomers and mixtures	X						X

The inventory and toxicity subcommittees consolidated POM compounds for several reasons. Many of the individual PAH compounds listed in the NEI did not have toxicity factors that were readily available. Additionally, these compounds usually result as a byproduct of combustion, and are usually found together. Finally, often PAHs are reported to EPA as individual compounds, but sometimes they are reported only as the total of a 7-PAH group, 16-PAH, or total POM group. Since individual PAH's can be added up into their appropriate PAH groupings, but individual compounds can not be readily determined when a PAH group is reported, the emissions data for the groups of PAHs are the most complete. The inventory for the total POM category is the most complete of all the PAH groups. That is, the MATI inventory is the most complete for

total POM. Additionally, the toxicological data on total POM/PAH is considered superior to the data on individual compounds that would be used to rank the “7-PAH” or “15/16-PAH” groups. For these reasons, all individual PAH compounds were summed together under the classification of POM.

3.4.3 Like Metal species

Heavy metals, such as chromium, are reported to the NEI as chromium and compounds, and where information was available, as specific chromium compounds, such as Chromium III, Chromium VI, and total elemental chromium. Similar to the PAH compounds, individual metal compounds can be added up into their respective metal groupings, but individual compounds can not be readily determined when a metal group is reported. Therefore, the emissions data for the groups of metals are the most complete. Additionally, a RSEI toxicity factor is not available for all forms of the metals, but is often available for the compound group. Therefore, the ATAC summed individual metal compounds into its appropriate “metal and compound” categories. For example, in the Appendix B Air Toxic List, the “NEI HAP Category” name, Manganese & Compounds, is the sum of the emissions of the compounds with the “NEI pollutants names”: Manganese & Compounds, Manganese Telluride, Manganese Sulfate, Manganesehypophosphite, Potassium permanganate, Manganese, Manganese Napthenate, Manganese Tetroxide, Manganese Trioxide, Manganese Dioxide, Manganese Nitrate, and Permanganic acid. Note that EPA assigns the names such as “Manganese & Compounds” to both a NEI HAP Category name, and NEI pollutant name. This can cause confusion, so caution had to be taken to properly add up all of the compounds in a metal group.

4. WEIGHTING EMISSIONS BASED ON TOXICITY

Some Air Toxics are more potent than others are. For example, while relatively low masses of Manganese, Nickel and 2,4-Toluene Diisocyanate are emitted in Maine, the toxicity of this compound gives it a relatively high potential for creating an adverse risk. In order to make policy decisions on which Air Toxics to focus reduction efforts on, it is necessary to determine the relative risk posed by a given contaminant. This determination must take into account not only the amount of the pollutant emitted to the air, but also the relative toxicity of the pollutant.

4.1 General Ranking Options

EPA preliminary guidance³⁰ suggests that there are three general options when assessing Hazardous Air Pollutant priorities:

1. not consider risk;
2. toxicity-weight emissions; or
3. conduct a formal risk assessment.

³⁰ EPA “Community Project How To Manual”, March 29, 2003 External Review Draft (Susan Lancy, EPA Region 1, One Congress Street, Suite 1100, Boston, MA 02114-2023; 617-918-1656; lancye.susan@epa.gov).

In the first approach, Air Toxic priorities are established by simply ranking ATs based upon emission mass (pounds of pollutant released each year). The advantage of this approach is that it is simple. The disadvantage is that state resources may be expended to reduce the release of a high mass pollutant that does not pose as much risk as a pollutant with lower release levels, but high toxicity. In this way the resources may be expended without reducing risk.

In the toxicity-weighted emission approach, release mass is multiplied times a toxicity factor. The advantage of the toxicity-weighting approach is that it is relatively simple, and provides a sense of potential risk. The disadvantage is that this approach does not account for actual exposure, or the amount of pollutant that is actually breathed by a person. Therefore, it does not indicate which pollutants pose an unacceptable risk, and it does not account for hot-spots, or areas of localized risks.

In the detailed risk assessment option, ATAC would first determine the mass of pollutant released. Then ATAC would assess the transformation of pollutants in the air as they are transported to people that breathe the air, the amount of the various pollutants that are actually breathed, and the resultant toxic impacts of this exposure, as shown in Figure 7 on page 27. The advantage of this approach is that we would have the greatest certainty about which pollutants are creating the greatest risk, the location of "hot-spots", and quantification of the risk so that we could determine if the risk is unacceptable. The disadvantage is that this approach requires detailed information on where and how all pollutants are released and sophisticated modeling. This in turn makes the approach resource and time intensive.

4.2 Calculation used to Toxicity-Weight emissions

ATAC used the formula in Equation 1 to determine the relative ranking of Air Toxics based on emission mass and toxicity. The Toxicity-Weighting approach is relatively crude, and it must be understood that the actual risks posed by the number 1 compound may not vary significantly from the risks posed by the compound ranked number 5.

Equation 1: Conversion of Mass Emissions to Toxicity-Weighted Emission

$$P_{TE} = P_W * P_T$$

Where: P = one of n Air Toxic Pollutants
 P_{TE} = Toxicity-Weighted Emission of Air Toxic "P" (risk pounds-pollutant "P" / year)
 P_W = Weight of Air Toxic P emitted to air in a year (pounds-pollutant "P"/ year)
 P_T = Toxicity Factor of Air Toxic "P" from RSEI (unitless)

Example Calculation:

Let:

p = Total acrolein

$$\begin{aligned}P_W &= 134,445 \text{ (pounds-pollutant} \\ &\text{"P"/ year)} \\ P_T &= 90,000 \text{ (unitless)} \\ \text{Therefore:} \\ P_{TE} &= P_W * P_T = 134,445 * 90,000 = \\ &12,100,050,000.00\end{aligned}$$

Each of the factors is discussed in detail in the sections below.

4.3 Weighting the Emissions Data Based on RSEI Toxicity Factors:

In order to weight emissions with toxicity, the ATAC needed a toxicity factor. The Toxicity Subcommittee selected the Toxicity Factors used in EPA's Risk-Screening Environmental Indicators (RSEI) model. This model was developed by EPA to assess the risk of releases reported in the TRI. To derive the toxicity factors for the RSEI model, EPA assessed a hierarchy of toxicity information, and derived a common risk weighting scale. The Toxicity Subcommittee selected the RSEI toxicity factors because they are frequently updated by EPA based on the latest toxicity information, are available for most of the air toxics contained in the MATI inventory, and they provide a method of evaluating carcinogens and non-carcinogens at the same time (see section 2.2.1 on page 18).

Sidebar 9: What is the Risk Screening Environmental Indicators Model?

RSEI is EPA's standard tool for ranking TRI data. It takes into account the fate and transport of a given compound to a receptor, the risk to a person breathing the compound, and the number of people that will be exposed. The Maine Department of Human Services recently rated the RSEI model as a preferred model for the MEDEP to evaluate TRI data for the MEDEP's Toxics Reduction Program. For more on this evaluation, see Carlson-Lynch, Heather and Andrew E. Smith, January 12, 2001, "Potential Uses of EPA's Risk-Screening Environmental Indicators Model for Prioritizing Toxics Use Reduction and Pollution Prevention Efforts" (Environmental Toxicology Program, Bureau of Health, Department of Human Services, , SHS 15, Augusta, ME 04333) For more information on RSEI, see EPA's RSEI website at:

<http://www.epa.gov/opptintr/rsei/whatsrsei.html>.

It should be noted that the factors used to derive the common weighting scale "maintain the equivalency between cancer and noncancer scores that was established in the Hazard Ranking System (HRS) scoring methodology used in EPA's Superfund program... When combining cancer and noncancer endpoints, it is assumed that exposure at the level of the RfD is equivalent to a 2.5×10^{-4} [incremental lifetime] cancer risk."³¹ In this way the RSEI factors weigh non-carcinogens more heavily vis-à-vis carcinogens than the MEDEP does (see section 2.2.2 on page 20). There is an implicit value judgment in this equivalence; other choices for equivalence could be made (see Table 1: "Acceptable Risk" Levels for MEDEP, MEDHHS and USEPA), and these other

³¹ EPA, User's Manual for RSEI Version 2.1 [1988-2000 TRI Data], December 2002 (EPA Office of Pollution Prevention and Toxics, Washington, DC 20460).
<http://www.epa.gov/opptintr/rsei/documents.html>

choices could result in different ranks of the ATs. For example, choosing a smaller cancer risk for the point of equivalence would give greater weight to carcinogens in the ranking scheme used in this document, and choosing a larger cancer risk would have the converse effect.

4.3.1 Updating Select RSEI Toxicity Factors

The latest RSEI factors available when this project was initiated had not been updated in two years. Maine DHS reviewed the underlying toxicology factors for the RSEI values for some 70 ATs for which the Maine DHS has established interim ambient air guidelines.³² These were the ATs of greatest concern in the mid 1980's. In cases where updated toxicological information was available, MEDEP updated the RSEI factor. The updated toxicological information is included in Appendix L.

4.3.2 Derivation of Missing RSEI Risk Factors

When a RSEI toxicity factor was not available for a given compound, the MEDEP consulted with MEDHHS and derived a toxicity factor in one of two ways. If sufficient toxicity information was available on the compound in EPA's Integrated Risk Information System (IRIS), then ATAC derived a toxicity factor using the same protocols that were used to derive the RSEI toxicity factor. These protocols are described in the "User's Manual for RSEI Version 2.1".³³ If insufficient information existed, a factor was derived using the Hierarchy that was developed by the Environmental Toxicology Program within the Maine Bureau of Human Services, for establishing the Maine Ambient Air Guidelines in April of 2004³⁴.

4.3.3 Chromium Toxicity Factor

It is important to note that Chromium is generally found in the environment as either trivalent chromium (Chromium III or Cr III) or hexavalent chromium (chromium VI or Cr VI), as determined by its valence state. Chromium III is much less toxic and more prevalent than chromium VI. The major target organ for both forms of chromium is the respiratory tract. Chromium (III) is an essential element in humans. The body converts some chromium (VI) to chromium (III).³⁵ Maine has established an ambient air quality standard for total and hexavalent chromium (see Table 6), which can be found at 38 MRSA §584-A.8. The Toxicity Factor in RSEI for Chromium that was used for the MATI project was specific to either Chromium III or Chromium VI. Therefore, the actual risk from Chromium and Compounds should be fairly accurate. This factor must be considered by the ATAC when determining what mitigation strategies might be appropriate.

³² Zeeman, Catherine Q.T., Memorandum of February 2, 1993, "Interim Ambient Air Guidelines" (Maine DEP, Bureau of Air Quality, 17 SHS, Augusta, ME 04333-0017)

³³ EPA, User's Manual for RSEI Version 2.1 [1988-2000 TRI Data], December 2002 (EPA Office of Pollution Prevention and Toxics, Washington, DC 20460).
http://www.epa.gov/opptintr/rsei/docs/users_manual.pdf

³⁴ Maine Bureau of Health, Ambient Air Guidelines, (MEDHHS Environmental Health Unit, 286 Water Street, SHS 11, Augusta, ME 04333-0011) April 2004

³⁵ USEPA, 1992, Health Effects Notebook for Hazardous Air Pollutants: Chromium and Compounds, available on EPA's Air Links Website at: <http://www.epa.gov/ttn/atw/hapindex.html>

Table 6: Maine Ambient Air Quality Standards for Air Toxics

Compound	Standard Type	Standard
Total Chromium	24-Hour Maximum	0.3 $\mu\text{g}/\text{m}^3$
Total Chromium	Annual Geometric Mean	0.05 $\mu\text{g}/\text{m}^3$
Hexavalent Chromium	Maximum Ambient Air Quality Impact	The greater of the minimum analytical detection limit or 1 ng/m^3
Lead	24-Hour Maximum	1.5 $\mu\text{g}/\text{m}^3$
Perchloroethylene	Annual Maximum	0.01 $\mu\text{g}/\text{m}^3$
Toluene	Maximum	15,000 $\mu\text{g}/\text{m}^3$
Toluene	24-Hour Maximum	260 $\mu\text{g}/\text{m}^3$
Toluene	Annual Maximum	180 $\mu\text{g}/\text{m}^3$

4.4 Selecting a Toxicity Factor for Polycyclic Organic Matter (POM)

The ATAC formed a toxicity subcommittee to evaluate how to establish a toxicity factor for Polycyclic Organic Matter (POM) and Polycyclic Aromatic Hydrocarbons. The Subcommittee's recommendations were approved at the May 25, 2004 full ATAC meeting. This class of compounds presented significant complexity in the available toxicological data on individual chemicals in the POM/PAH categories and uncertainty in the application of these data to mixtures of POM/PAH. In order to address the charge, the Subcommittee conducted closer evaluation of the emissions data, toxicological data, estimates of health risks from POM/PAH exposure, and information used by California EPA, to derive a toxicity weight of 6400 (unitless).

The toxicity weight is based on the World Health Organization's unit risk of 90 per mg/m^3 for benzo(a)pyrene as an indicator for exposure to a mixture of POM/PAH. The toxicity weight incorporates an assumption that benzo(a)pyrene represents approximately 1% of total POM/PAH emissions from combustion sources. Emissions factors for residential wood combustion both from the National Emissions Inventory (NEI) and from Bostrom³⁶ support the assumption of 1% BaP. The assumption of 1 % BaP for Mobile sources is also supported by Mobile source emission estimates from the NEI³⁷.

³⁶ Bostrom, C-E., P. Gerde, A. Hanberg, et al. 2002. Cancer risk assessment, indicators, and guidelines for polycyclic aromatic hydrocarbons in the ambient air. *Environ. Health Perspectives* 110 (Suppl. 3): 451-489.

³⁷ A full discussion of the derivation of the toxicity factor for POM, including other options for ranking that the Subcommittee considered, is included in "Draft Recommendations on Toxicity Factors for Polycyclic Aromatic Hydrocarbons and Polycyclic Organic Matter 6-22-04", which is available in the MATI document archive at: <http://www.maine.gov/dep/air/toxics/mati-docs.htm>.

Additionally, California EPA has conducted an evaluation of the unique susceptibility of children to the health effects of POM. CA-EPA concluded that POM should be within the top tier (Tier 1) of toxic air contaminants that could cause infants or

children to be susceptible to illness. The Tier 1 ranking is based on both greater exposures to children and on evidence of greater toxicological susceptibility.³⁸ (See Sidebar 10: The major findings leading to CA-EPA's Tier 1 ranking of POM)

Sidebar 10: The major findings leading to CA-EPA's Tier 1 ranking of POM

- Many PAHs and PAH mixtures have been shown to be carcinogenic to animals and/or humans. Carcinogen exposure early in life may have greater overall impact than exposure to adults. Experimental data suggest young animals may be more sensitive to the carcinogenicity of certain PAHs and PAH derivatives.
- Prenatal PAH exposure is associated with numerous noncancer effects, including teratogenesis, low birth weight, immunotoxicity, loss of fertility, and hematopoietic effects, even at doses that do not cause maternal toxicity.
- PAHs are transplacental carcinogens, and the sensitivity and diversity of tumor sites is greater in transplacental carcinogenesis. (In transplacental carcinogenesis, toxicants circulating in the maternal bloodstream cross the placenta and render the fetus more susceptible to cancer.)
- Children's exposures to PAHs are generally higher than adults' exposures in the same setting.

4.5 Selecting a Toxicity Factor for Diesel Particulate Matter (DPM)

The Toxicity Subcommittee also developed recommendations as to how diesel particulate matter (DPM) should be ranked within the overall Air Toxics Priority List (ATPL), which the ATAC approved on May 25, 2004. The Subcommittee conducted closer evaluation of the available emissions information, toxicological data, estimates of health risks from DPM exposure, and the available information on potential levels of DPM in Maine, and recommended that diesel particulate matter be ranked using a range of toxicity weights from 360 to 2100. The lower toxicity weight (360) is based on a USEPA Reference Concentration and is considered protective for the potential noncancer effects of chronic exposure to DPM. The higher toxicity weight (2100) reflects an estimate of the inhalation unit risk for DPM developed by California's Environmental Protection Agency (CA-EPA). The ATAC acknowledges that the scientific community does not appear to have reached a consensus on an inhalation cancer unit risk for DPM. USEPA elected not to develop a quantitative estimate of cancer risks

from inhalation of DPM due to the uncertainty in the available data. However, the ATAC determined that neglecting the potential carcinogenicity of DPM in the ranking process

³⁸ CA-EPA, 2001. Prioritization of Toxic Air Contaminants – Children's Environmental Health Protection Act: Polycyclic Organic Matter.

was not acceptable given the general consensus that DPM exposure is associated with an increased risk of cancer.³⁹

4.6 Results of Toxicity-Weighting Emissions

The result of weighting each air toxic by its toxicity factor is shown in Table 7. This table is sorted by the total toxicity score, as derived from Equation 1 on page 43. Note that the scores are subject to available emissions inventory and toxicity information, as described above. These rankings also do not take into account other factors, as described in the following sections of this basis statement.

Table 7: Ranking of Air Toxic's based solely on Toxicity-Weighted Emissions

Toxicity-Weighted Rank	Pollutant Category	Toxicity-Weighted Emissions (unitless)	% of Total Tox -Weight
1	Acrolein	16,361,357,067	66.1%
2	POM	1,614,157,699	6.5%
3	Manganese	1,168,475,039	5%
4	Formaldehyde	986,993,386	4%
5	Nickel	956,885,478	4%
6	1,3-Butadiene	760,650,004	3%
7	Diesel PM	692,367,120	3%
8	2,4-Toluene Diisocyanate	552,769,351	2%
9	Sulfuric Acid	315,805,000	1%
10	Benzene	174,286,869	1%
11	Acetaldehyde	132,014,898	1%
12	Lead	124,323,868	1%
13	Cadmium	110,647,841	0.4%
14	Methyl Bromide	100,173,587	0.4%
15	Chlorine	90,942,800	0.4%
16	Hydrochloric Acid	89,637,039	0.4%
17	Chlorine Dioxide	80,424,000	0.3%
18	Toluene	58,657,863	0.2%
19	Dioxins	54,531,144	0.2%
20	Chromium	41,391,854	0.2%
21	Arsenic	40,437,761	0.2%
22	Cyanide & Compounds	36,710,735	0.1%
23	Glycol Ethers	26,018,401	0.1%
24	Hydrogen Fluoride	22,240,551	0.1%
25	Ammonia	18,902,531	0.1%
26	1,3-Dichloropropene	18,043,801	0.1%
27	Hexane	16,894,581	0.1%

³⁹ The subcommittee's full recommendations with respect to ranking DPM and the relevant information that lead to the recommendations, including other options for ranking that the Subcommittee considered, are contained in "Draft Recommendations on Toxicity Factors for Ranking Diesel Particulate matter 6-22-04", which is available in the MATI document archive at: <http://www.maine.gov/dep/air/toxics/mati-docs.htm>.

Toxicity-Weighted Rank	Pollutant Category	Toxicity-Weighted Emissions (unitless)	% of Total Tox -Weight
28	Xylenes (Mixture of o, m, and p Isomers)	16,780,316	0.1%
29	Chloroform	14,182,195	0.1%
30	Selenium	10,643,039	0.04%
31	Tetrachloroethylene (Perchloroethylene)	10,589,465	0.04%
32	Cobalt	6,628,084	0.03%
33	Beryllium	4,471,590	0.02%
34	4,4'-Methylenediphenyl Diisocyanate	3,831,399	0.02%
35	Ethylene Glycol	3,740,673	0.02%
36	Hydrogen Sulfide	3,379,310	0.01%
37	Ethyl Benzene	2,843,039	0.01%
38	Methyl Ethyl Ketone	2,687,438	0.01%
39	2,2,4-Trimethylpentane	2,523,168	0.01%
40	Mercury	2,519,927	0.01%
41	Methyl Isobutyl Ketone	2,431,850	0.01%
42	Methylene Chloride	2,038,792	0.01%
43	Trichloroethylene	1,622,606	0.01%
44	Propionaldehyde	1,510,355	0.01%
45	Methyl Tert-Butyl Ether	1,455,147	0.01%
46	Methanol	1,327,959	0.01%
47	Butyl Cellosolve	1,280,759	0.01%
48	Methyl Chloroform	940,823	0.004%
49	Styrene	818,361	0.003%
50	N,N-Dimethylformamide	806,865	0.003%
51	Phenol	779,124	0.003%
52	1,4-Dichlorobenzene	776,278	0.003%
53	Acrylonitrile	566,840	0.002%
54	Propylene Oxide	393,244	0.002%
55	Maleic Anhydride	380,568	0.002%
56	Acrylic Acid	358,093	0.001%
57	Methyl Chloride	321,554	0.001%
58	1,2,4-Trichlorobenzene	317,414	0.001%
59	Triethylamine	273,305	0.001%
60	Cumene	249,529	0.001%
61	Barium	206,475	0.001%
62	Biphenyl	195,255	0.001%
63	Chlorobenzene	162,117	0.001%
64	Antimony	154,240	0.001%
65	Cresol	137,219	0.001%
66	Carbon Tetrachloride	103,334	0.0004%
67	Ethylene Oxide	85,528	0.0003%
68	Aniline	80,333	0.0003%
69	Ethylene Dichloride	75,688	0.0003%
70	2-Nitropropane	69,551	0.0003%
71	1,2,4-Trimethylbenzene	52,000	0.0002%
72	Chloroprene	47,564	0.0002%
73	N,N-Dimethylaniline	46,636	0.0002%

Toxicity-Weighted Rank	Pollutant Category	Toxicity-Weighted Emissions (unitless)	% of Total Tox -Weight
74	Chloromethyl Methyl Ether	43,026	0.0002%
75	Methyl Methacrylate	37,931	0.0002%
76	Phosphorus & Compounds	37,056	0.0001%
77	Cellosolve Solvent	29,600	0.0001%
78	Allyl Chloride	24,755	0.0001%
79	Catechol	21,667	0.0001%
80	Carbon Disulfide	20,808	0.0001%
81	2,4,6-Trichlorophenol	20,680	0.0001%
82	Diethanolamine	19,828	0.0001%
83	2,4-Dinitrotoluene	19,160	0.0001%
84	Vinylidene Chloride	16,601	0.0001%
85	Propylene Dichloride	16,404	0.0001%
86	Carbonyl Sulfide	15,912	0.0001%
87	Phosphorus	13,574	0.0001%
88	PCBs	13,350	0.0001%
89	Epichlorohydrin	12,309	0.00005%
90	Vinyl Chloride	10,308	0.00004%
91	Cellosolve Acetate	10,246	0.00004%
92	Ethylene Dibromide	9,314	0.00004%
93	1,1,2,2-Tetrachloroethane	9,255	0.00004%
94	Vinyl Acetate	8,488	0.00003%
95	ZINC	8,467	0.00003%
96	Hydrazine	7,895	0.00003%
97	Acetonitrile	6,266	0.00003%
98	Isophorone	5,799	0.00002%
99	Nitrobenzene	5,623	0.00002%
100	Bis(2-Ethylhexyl)Phthalate	5,580	0.00002%
101	Bis(Chloromethyl)Ether	4,811	0.00002%
102	Hexachlorocyclopentadiene	4,738	0.00002%
103	Acrylamide	4,461	0.00002%
104	Dibutyl Phthalate	3,539	0.00001%
105	Quinoline	3,230	0.00001%
106	Ethyl Acrylate	3,204	0.00001%
107	Titanium Tetrachloride	3,145	0.00001%
108	Acetophenone	2,759	0.00001%
109	Ethyl Chloride	2,172	0.00001%
110	Benzyl Chloride	1,886	0.00001%
111	o-Anisidine	1,842	0.00001%
112	Benzotrichloride	1,775	0.00001%
113	p-Dioxane	1,654	0.00001%
114	1,2-Propylenimine	1,398	0.00001%
115	Dimethyl Sulfate	1,226	0.00000%
116	Ethylidene Dichloride	1,009	0.00000%
117	Xylene	942	0.00000%
118	Phthalic Anhydride	818	0.00000%
119	Quinone	637	0.00000%

Toxicity-Weighted Rank	Pollutant Category	Toxicity-Weighted Emissions (unitless)	% of Total Tox -Weight
120	o-Toluidine	523	0.00000%
121	Methyl Isocyanate	513	0.00000%
122	Methyl Iodide	435	0.00000%
123	Hexachlorobenzene	239	0.00000%
124	4,4'-Methylenedianiline	221	0.00000%
125	Diethyl Sulfate	160	0.00000%
126	Phosgene	127	0.00000%
127	1,1,2-Trichloroethane	41	0.00000%
128	Hydroquinone	40	0.00000%
129	Pentachlorophenol	39	0.00000%
130	Dichloroethyl Ether	24	0.00000%
131	Chloroacetic Acid	23	0.00000%
132	Vinyl Bromide	22	0.00000%
133	Acetamide	21	0.00000%
134	Dichlorvos	19	0.00000%
135	1,1-Dimethyl Hydrazine	18	0.00000%
136	Hexachlorobutadiene	7	0.00000%
137	4,6-Dinitro-o-Cresol	6	0.00000%
138	Dibenzofuran	6	0.00000%
139	4-Nitrophenol	4	0.00000%
140	Heptachlor	3	0.00000%
141	Pentachloronitrobenzene	3	0.00000%
142	Chlordane	2	0.00000%
143	Methylhydrazine	1	0.00000%
144	Captan	0.4	0.00000%
145	3,3'-Dichlorobenzidene	0.3	0.00000%
146	2,4-Dichlorophenoxy Acetic Acid	0.3	0.00000%
147	p-Phenylenediamine	0.2	0.00000%
148	Carbaryl	0.1	0.00000%
149	2,4-Dinitrophenol	0.01	0.00000%
150	Dimethyl Phthalate	0.003	0.00000%
151	Trifluralin	0.003	0.00000%
152	Hexachloroethane	0.001	0.00000%
153	Styrene Oxide	0.0001	0.00000%
	Grand Total	24,751,122,967	100%

It should be noted that there is a high uncertainty in the emission factor for acrolein from wood-fired boilers, due to a broad range in stack-test results from these types of facilities. Emission factors for these types of emission sources range from 4 E-03 (AP-42 factor) to 8 E-05 (NCASI factors) lbs of acrolein per Million BTUs of wood burned. For this analysis, the ATAC applied the NCASI factor to wood fired boilers at papermills, which may underestimate actual emissions. ATAC applied the AP-42 emission factor to other large wood boilers, which may over-estimate actual emissions. If the AP-42 factor had been used throughout the inventory, the toxicity-weighted emissions would have been 265% higher in the overall inventory. If the NCASI factor had been used

throughout the inventory, the toxicity-weighted emissions would have been 60% lower. Further details on this sensitivity analysis are available on the MEDEP's MATI Website at: <http://www.maine.gov/dep/air/toxics/mati-docs.htm>.

5. ASSESSING WHICH TOXICITY-WEIGHTED COMPOUND SHOULD BE ADDED TO THE ATPL

5.1 Reason for Benchmarking Toxicity-Weighted-Emissions

The ATPL ranking based on Toxicity-Weighting prioritizes the ATs relative to each other, but does not determine which pollutants may currently be posing an actual risk problem. That is, it does not indicate if all of the ATs pose a risk, or only the top 10, or none. Section 2.2.2 contains a discussion of what regulatory agencies consider "acceptable risk". It is important to note that not all ATAC members agree on what constitutes "unacceptable risk". Many believe that this is a sliding scale that must consider the economic impacts of controls. However, it is important to focus any further actions in areas that will result in the most protection of public health. To address the need to determine which toxicity-weighted emissions pose a potential risk, and therefore require further consideration, the Benchmarking Subcommittee compared the ATAC's Toxicity-Weighted priority list to the 31 compounds assessed in the 1996 National Air Toxics Assessment, which did quantify risk. In this way the Benchmarking Subcommittee was able to calibrate, or benchmark, Maine's AT priority list to actual risk levels, and then screen out pollutants that did not warrant further consideration. The subcommittee selected the 1996 NATA, since it was the most recent, publicly available, statewide risk assessment.

5.2 Updating the 1996 NATA to Determine Current Risk

A significant issue that the benchmarking subcommittee needed to address was that the NATA modeling was done using 1996 emission data, which does not accurately represent existing emissions, because the industrial profile in Maine is different today than it was in 1996, and several AT control programs have been implemented in the state since 1996. If the 1996 NATA emission input values do not represent current emissions, the resultant risk determinations will also not represent current conditions. Therefore, the subcommittee simplistically applied the ratio of current emissions and 1996 emissions, to the 1996 NATA risk, to obtain a rough estimate of the current risk. EPA⁴⁰ thought that this was a reasonable approach for benchmarking purposes, since the NATA modeling is roughly linear within the major inventory sectors. To the extent that the relationship is not linear, this approach will either over or underestimate risk. Further, both the 1996 NATA and the benchmarking step are screening-level risk assessments. Both are intended to help focus further action, rather than providing definitive estimates of actual risk.

To adjust the 1996 NATA risk results to the current 2005 MATI Inventory, the benchmarking subcommittee used Equation 2:

⁴⁰ Ted Palma at Office of Air Quality and Program Standards in Research Triangle Park, in a teleconference with the benchmarking subcommittee on August 3, 2004.

Equation 2: Adjusting the 1996 NATA Risk to Estimated 2005 MATI Inventory Emissions

$$2005 \text{ Risk} / 2005 \text{ Inventory} = 1996 \text{ Risk} / 1996 \text{ Inventory}$$

Cross multiply to obtain:

$$P_{2005} \text{ Risk} = P_{2005} \text{ Inventory} * P_{1996} \text{ Risk} / P_{1996} \text{ Inventory}$$

Where:

$P_{2005} \text{ Risk}$ - Is the risk posed by a pollutant in a given county from a given major inventory sector based on 2005 emissions. For carcinogens, the risk is expressed as an Incremental Life-Time Cancer Risk (ILCR). For Non-carcinogens, the risk is expressed as a Hazard Index (HI).

$P_{2005} \text{ Inventory}$ - Is the 2005 Hazardous Air Pollutant (HAP) inventory, from a given major inventory sector, which was developed for the Maine Air Toxics Initiative (MATI).

$P_{1996} \text{ Risk}$ - Is the risk posed by a pollutant in a given county, from a given major inventory sector, based on 1996 emissions, as modeled for the National Air Toxics Assessment (NATA). For carcinogens, the risk is expressed as an ILCR. For Non-carcinogens, the risk is expressed as an HI.

$P_{1996} \text{ Inventory}$ - Is the 1996 HAP emissions inventory, from a given major inventory sector, which was used as model inputs for the 1996 NATA risk determination.

5.2.1 Adjustments for Border Effects

In undertaking the 1996 NATA, EPA's ASPEN model distributed emissions 50KM downwind, regardless of the county boundary. Thus pollutants emitted from New Hampshire facilities within 50 KM of the Maine border increased the risk in Maine locations. These increases in risk from New Hampshire emission sources were generally negligible in comparison to the total risk in the Maine County, since the New Hampshire emissions were greatly attenuated before entering the Maine County. However, in one instance, emissions in Berlin New Hampshire dominated the Point Source risk estimates for Oxford County in Maine, due to the very low reported emissions for Point Sources in Oxford County in 1996. Therefore, when the risks were ratioed against realistic 2005 Oxford Point emission estimates (using Equation 2), the risks calculated for 2005 were unrealistically high for Formaldehyde (ILCR=7.4E-05) and Acetaldehyde (ILCR=1.5E-05). Therefore, the inventory and benchmarking subcommittees adjusted these results. The subcommittees applied the ratio of 1996

Area Source risk and emissions to the 2005 Point Source emissions, to obtain the 2005 risk, as follows:

Equation 3: Adjusting the 1996 NATA Risk to 2005 MATI Inventory Emissions for Point Sources in Oxford County

$$\begin{array}{ccccccc} \text{2005 Risk} & / & \text{2005 Inventory} & = & \text{1996 Risk} & / & \text{1996 Inventory} \\ \text{Point} & & \text{Point Sources} & & \text{for Area} & & \text{for Area} \\ \text{Sources} & & \text{in Oxford Co.} & & \text{Sources} & & \text{Sources in} \\ \text{in Oxford} & & & & \text{in Oxford} & & \text{Oxford Co.} \\ \text{Co.} & & & & \text{Co.} & & \end{array}$$

Cross multiply to obtain:

$$P_{2005 \text{ Risk}} = P_{2002 \text{ Inventory}} * P_{1996 \text{ Risk}} / P_{1996 \text{ Inventory}}$$

Where:

$P_{2005 \text{ Risk}}$	Is the risk posed by a pollutant in Oxford County from Point Sources based on 2005 emissions. For carcinogens, the risk is expressed as an Incremental Life- Time Cancer Risk (ILCR). For Non-carcinogens, the risk is expressed as a Hazard Index (HI).
$P_{2005 \text{ Inventory}}$	Is the 2005 Hazardous Air Pollutant (HAP) inventory for Point Sources for a given pollutant, which was developed for the Maine Air Toxics Initiative (MATI).
$P_{1996 \text{ Risk}}$	Is the risk posed by a pollutant in Oxford County, from Area Sources, based on 1996 emissions, as modeled for the National Air Toxics Assessment (NATA). For carcinogens, the risk is expressed as an ILCR. For Non-carcinogens, the risk is expressed as an HI.
$P_{1996 \text{ Inventory}}$	Is the 1996 HAP emissions inventory, from Area Sources in Oxford Co., which was used as model inputs for the 1996 NATA risk determination.

5.2.2 Missing Emission Values for 1996

The benchmarking subcommittee noted that there were several cases where a pollutant's emission estimate for a given sector in a county had not be made in 1996, but the MATI inventory did include emission estimates for this sector. In these cases, 2005 Risk estimates could not be derived. For instance, in 1996 the NATA did not include risk estimates for acrolein from Point Sources in Cumberland, Androscoggin, Aroostook, and Penobscot counties. Therefore, while Point Sources released over

34,400 pounds of acrolein in these counties in 2005, the risk from these releases could not be estimated using the above procedures. This results in an underestimation of risk.

In response to this issue, the benchmarking subcommittee explored applying the ratio of emissions to risk for the Area Source category in these cases, similar to Equation 3. The EPA staff that conducted the 1996 NATA recommended that the ATAC not use this approach, since the dispersion assumptions are very different between sectors. However, the benchmarking subcommittee did perform a sensitivity analysis, and found that using this approach would likely have had negligible effect, as shown in Table 8. Further, detailed calculations are available on the MATI website.

Table 8: Sensitivity Analysis of Filling in Missing 1996 Emissions Using Area Source Risk:Emissions

Scenario	No Fill, No Oxford Change*	No Fill, Change Oxford**	Fill, No Oxford Change***	No Fill, No Oxford Change*	No Fill, Change Oxford**	Fill, No Oxford Change***
County	Total ILCR 2005			Total HI 2005		
Androscoggin Total	3.0E-05	3.0E-05	3.0E-05	1.04	1.04	1.04
Aroostook Total	2.1E-05	2.1E-05	2.1E-05	0.14	0.14	0.14
Cumberland Total	3.2E-05	3.2E-05	3.2E-05	1.51	1.51	1.51
Franklin Total	2.1E-05	2.1E-05	2.1E-05	0.21	0.21	0.21
Hancock Total	2.2E-05	2.2E-05	2.2E-05	0.27	0.27	0.27
Kennebec Total	2.6E-05	2.6E-05	2.6E-05	0.57	0.57	0.57
Knox Total	1.9E-05	1.9E-05	1.9E-05	0.31	0.31	0.31
Lincoln Total	2.1E-05	2.1E-05	2.1E-05	0.37	0.37	0.37
Oxford Total	1.1E-04	2.0E-05	2.0E-05	0.97	0.97	0.97
Penobscot Total	2.4E-05	2.4E-05	2.4E-05	0.43	0.43	0.43
Piscataquis Total	2.1E-05	2.1E-05	2.1E-05	0.17	0.17	0.17
Sagadahoc Total	3.1E-05	3.1E-05	3.1E-05	0.99	0.99	0.99
Somerset Total	2.1E-05	2.1E-05	2.1E-05	0.18	0.18	0.18
Waldo Total	2.3E-05	2.3E-05	2.3E-05	0.36	0.36	0.36
Washington Total	2.0E-05	2.0E-05	2.0E-05	0.17	0.17	0.17
York Total	2.6E-05	2.6E-05	2.6E-05	0.72	0.72	0.72

*"No Fill, No Oxford Change" means the scenario in which the emission calculations were conducted in accordance with Equation 2, missing emission values (as described in section 5.2.2) were not filled in, and no adjustments were made for the border effect described in section 5.2.1.

**"No Fill, Change Oxford" means the scenario in which the emissions were conducted in accordance with Equation 2, missing emission values (as described in section 5.2.2) were not filled in, but adjustments to Oxford County were made to adjust for the border effect, as described in Equation 3. This is the Scenario carried forward in this document.

***"Fill, No Oxford Change" means that when there were emissions for a given sector in 2005 but not in 1996, the ratio of 1996 Emissions:1996 Risk for the *Area Source* sector was applied to 2005 emissions (similar to Equation 3). Also, the adjustment to Oxford County was not made.

5.2.3 Assessing Risk from “Background” Concentrations

The overall risk in the 1996 NATA included the risk posed by background concentrations of the pollutants listed in Table 9. These concentrations were intended to account for “long-range transport, resuspension of historical emissions, and nonanthropogenic sources”, which were not included in the emissions inventory. For this benchmarking, the subcommittee assumed that the risk due to background concentrations in 2005 was equal to the risks due to background in 1996, as shown in Equation 4.

Equation 4: Risk from Background Concentrations of Pollutants

$$P_{2005 \text{ Risk from Background}} = P_{1996 \text{ Risk from Background}}$$

Where:

- $P_{2005 \text{ Risk from Background}}$ Is the year 2005 risk that is posed by a pollutant in a given county based on background concentrations. For carcinogens, the risk is expressed as an ILCR. For Non-carcinogens, the risk is expressed as a HI.
- $P_{1996 \text{ Risk from Background}}$ Is the risk posed by a pollutant in a given county based on 1996 based on background concentrations, as modeled for the National Air Toxics Assessment (NATA). For carcinogens, the risk is expressed as an ILCR. For Non-carcinogens, the risk is expressed as a HI.

Table 9: Background Pollutant Concentration Used by EPA in the 1996 NATA

Pollutant	Background Concentration (µg/m3)
Benzene	0.48
Carbon tetrachloride	0.88
Chloroform	0.083
Ethylene dibromide	0.0077
Ethylene dichloride	0.061
Formaldehyde	0.25
Hexachlorobenzene	0.000093
Mercury compounds	0.0015
Methylene chloride	0.15
Polychlorinated biphenyls	0.00038
Perchloroethylene (Tetrachloroethylene)	0.14
Trichloroethylene	0.081

5.2.4 Over-all Risk by Each Pollutant in Each County

Risk was approximated for each pollutant, in each county for the following sectors: Point, Area, Mobile/off-road, Mobile/on-road, and background. The total risk from each pollutant in each county was then added using Equation 5. In accordance with standard risk assessment protocols, carcinogens and non-carcinogens were assessed separately (see section 2.2 on page 18).

Equation 5: Total Risk for Each Pollutant in Each County

$$P_{\text{Total}} = P_{\text{Point}} + P_{\text{Area}} + P_{\text{non-road}} + P_{\text{onroad}} + P_{\text{background}}$$

Where:

P_{Total}	Is the Total Risk (expressed as either a HI or ILCR) for pollutant P in each county
P_{Point}	Is the Risk from Point Source emissions (expressed as either a HI or ILCR) for pollutant P in each county
P_{Area}	Is the risk from Area Source emissions (expressed as either a HI or ILCR) for pollutant P in each county
$P_{\text{non-road}}$	Is the risk from non-road source emissions (expressed as either a HI or ILCR) for pollutant P in each county
P_{onroad}	Is the risk from onroad source emissions (expressed as either a HI or ILCR) for pollutant P in each county
$P_{\text{background}}$	Is the risk from background concentrations (expressed as either a HI or ILCR) for pollutant P in each county

All of the calculations done for the benchmarking portion of the initiative are available on the MATI website in the document archive at: <http://www.maine.gov/dep/air/toxics/mati-docs.htm#minutes>. The results of the screening-level risk estimates are shown in Table 10 and Table 11. These results include the correction for border effects, as discussed in section 5.2.1. See section 5.2.2 for a discussion of the lack of 1996 emission estimates on this determination. The impacts of mixtures of pollutants are considered in section 5.2.5. It is important to remember that localized areas within the county will likely have a much higher risk from the compounds in these tables, while large portions of the county will have a lower risk.

**Table 10: Current Incremental Lifetime Cancer Risks Greater than 1 in a Million
Posed by Individual Air Toxics on a County- Wide Basis (Based Upon Screening
Risk Estimation Procedures)**

Pollutant	County	Point ILCR 2005	Area ILCR 2005	Onroad Mobile ILCR 2005	Nonroad Mobile ILCR 2005	Back-ground ILCR 2005	Total ILCR 2005
Carbon Tetrachloride	Waldo		2.1E-10			9.6E-06	9.6E-06
Carbon Tetrachloride	Kennebec	No 96 Emissions	4.9E-10			9.6E-06	9.6E-06
Carbon Tetrachloride	Piscataquis		4.2E-11			9.6E-06	9.6E-06
Carbon Tetrachloride	Androscoggin	No 96 Emissions	8.6E-10			9.6E-06	9.6E-06
Carbon Tetrachloride	Aroostook	No 96 Emissions	8.4E-11			9.6E-06	9.6E-06
Carbon Tetrachloride	Penobscot	No 96 Emissions	3.6E-11			9.5E-06	9.5E-06
Carbon Tetrachloride	Sagadahoc	No 96 Emissions	2.7E-09			9.3E-06	9.3E-06
Carbon Tetrachloride	Franklin		9.0E-11			9.3E-06	9.3E-06
Carbon Tetrachloride	York	No 96 Emissions	8.4E-10			9.2E-06	9.2E-06
Carbon Tetrachloride	Cumberland	No 96 Emissions	7.4E-10			9.1E-06	9.1E-06
Carbon Tetrachloride	Hancock		1.1E-10			9.1E-06	9.1E-06
Carbon Tetrachloride	Washington	No 96 Emissions	5.6E-11			9.0E-06	9.0E-06
Carbon Tetrachloride	Somerset	No 96 Emissions	5.3E-11			9.0E-06	9.0E-06
Carbon Tetrachloride	Lincoln		3.6E-10			8.8E-06	8.8E-06
Carbon Tetrachloride	Knox		2.9E-10			8.0E-06	8.0E-06
Carbon Tetrachloride	Oxford		2.5E-10			7.5E-06	7.5E-06
Benzene	Sagadahoc	No 96 Emissions	8.1E-07	2.0E-06	1.6E-06	3.0E-06	7.3E-06
Benzene	Cumberland	6.5E-08	6.5E-07	3.0E-06	4.1E-07	3.0E-06	7.1E-06
Benzene	Androscoggin	No 96 Emissions	6.3E-07	2.2E-06	5.8E-07	3.1E-06	6.5E-06
Formaldehyde	Cumberland	3.0E-08	1.3E-07	2.7E-06	1.2E-06	2.1E-06	6.1E-06
Benzene	York	No 96 Emissions	3.1E-07	1.9E-06	2.2E-07	3.0E-06	5.4E-06
Benzene	Kennebec	1.1E-11	3.4E-07	1.5E-06	1.6E-07	3.1E-06	5.2E-06
Formaldehyde	Androscoggin	4.0E-07	1.2E-07	2.0E-06	3.0E-07	2.2E-06	5.0E-06
Formaldehyde	Sagadahoc		8.9E-08	2.0E-06	7.6E-07	2.1E-06	5.0E-06
Benzene	Penobscot	7.4E-09	1.5E-07	1.2E-06	8.1E-08	3.1E-06	4.6E-06
Formaldehyde	York	No 96 Emissions	7.1E-08	1.9E-06	2.4E-07	2.1E-06	4.3E-06
Benzene	Waldo	No 96 Emissions	1.1E-07	5.7E-07	3.1E-07	3.1E-06	4.1E-06
Formaldehyde	Kennebec		6.3E-08	1.4E-06	2.4E-07	2.2E-06	3.9E-06
Benzene	Lincoln		8.6E-08	5.1E-07	3.1E-07	2.9E-06	3.8E-06
Benzene	Hancock	1.4E-08	6.9E-08	4.9E-07	1.6E-07	3.0E-06	3.7E-06
Benzene	Franklin	1.4E-08	2.8E-08	2.6E-07	2.6E-07	3.0E-06	3.6E-06
Benzene	Aroostook	No 96 Emissions	3.1E-08	2.7E-07	4.0E-08	3.2E-06	3.5E-06
Benzene	Knox		1.2E-07	4.8E-07	2.7E-07	2.6E-06	3.5E-06
Benzene	Somerset	2.5E-09	2.2E-08	3.9E-07	1.4E-07	2.9E-06	3.5E-06
Benzene	Piscataquis	No 96 Emissions	2.5E-08	1.4E-07	1.1E-07	3.2E-06	3.4E-06
Benzene	Washington	5.9E-09	3.5E-08	1.7E-07	1.0E-07	3.0E-06	3.3E-06
Formaldehyde	Penobscot	1.9E-08	2.3E-08	7.3E-07	2.1E-07	2.2E-06	3.2E-06
Formaldehyde	Waldo		1.7E-08	3.9E-07	3.9E-07	2.2E-06	3.0E-06
Benzene	Oxford	5.5E-09	7.9E-08	3.6E-07	6.7E-08	2.5E-06	3.0E-06
Formaldehyde	Lincoln		2.0E-08	4.8E-07	2.6E-07	2.0E-06	2.8E-06
Formaldehyde	Franklin	9.4E-08	6.0E-09	1.9E-07	1.8E-07	2.2E-06	2.6E-06

Pollutant	County	Point ILCR 2005	Area ILCR 2005	Onroad Mobile ILCR 2005	Nonroad Mobile ILCR 2005	Back-ground ILCR 2005	Total ILCR 2005
Formaldehyde	Hancock	1.6E-08	1.2E-08	3.4E-07	1.2E-07	2.1E-06	2.6E-06
Formaldehyde	Aroostook	7.8E-08	5.5E-09	1.5E-07	1.3E-07	2.3E-06	2.6E-06
Formaldehyde	Piscataquis	No 96 Emissions	2.9E-09	1.0E-07	2.4E-07	2.3E-06	2.6E-06
Formaldehyde	Somerset	2.4E-08	4.8E-09	2.8E-07	1.6E-07	2.1E-06	2.6E-06
Formaldehyde	Knox		2.6E-08	4.0E-07	2.5E-07	1.9E-06	2.5E-06
Formaldehyde	Washington	1.8E-08	5.3E-09	1.0E-07	9.5E-08	2.1E-06	2.3E-06
Formaldehyde	Oxford	4.5E-08	9.8E-09	2.7E-07	8.8E-08	1.8E-06	2.2E-06
Chloroform	Somerset	1.1E-08	5.3E-07			1.4E-06	2.0E-06
Chloroform	Waldo		1.6E-07			1.6E-06	1.7E-06
Chloroform	Sagadahoc	No 96 Emissions	2.2E-07			1.5E-06	1.7E-06
Chloroform	Androscoggin	No 96 Emissions	1.4E-07			1.6E-06	1.7E-06
Chloroform	Cumberland	4.3E-12	2.2E-07			1.5E-06	1.7E-06
Chloroform	Franklin	1.5E-07	2.0E-08			1.5E-06	1.7E-06
Chloroform	York	No 96 Emissions	1.2E-07			1.5E-06	1.6E-06
Chloroform	Kennebec	2.0E-13	4.0E-08			1.6E-06	1.6E-06
Chloroform	Penobscot	8.4E-09	3.9E-08			1.5E-06	1.6E-06
Chloroform	Piscataquis		8.2E-09			1.6E-06	1.6E-06
Chloroform	Aroostook	No 96 Emissions	2.6E-09			1.6E-06	1.6E-06
Chloroform	Lincoln		1.1E-07			1.4E-06	1.5E-06
Chloroform	Hancock		1.8E-08			1.5E-06	1.5E-06
Perchloroethylene	Sagadahoc	No 96 Emissions	9.2E-07			5.5E-07	1.5E-06
Chloroform	Washington	2.3E-09	5.9E-09			1.5E-06	1.5E-06
Ethylene Dichloride	Waldo		9.3E-11			1.4E-06	1.4E-06
Ethylene Dichloride	Piscataquis		3.5E-09			1.4E-06	1.4E-06
Ethylene Dichloride	Kennebec	No 96 Emissions	1.7E-10			1.4E-06	1.4E-06
Ethylene Dichloride	Aroostook	No 96 Emissions	5.6E-11			1.4E-06	1.4E-06
Ethylene Dichloride	Androscoggin	No 96 Emissions	1.8E-10			1.4E-06	1.4E-06
Ethylene Dichloride	Penobscot	No 96 Emissions	7.7E-11			1.4E-06	1.4E-06
Ethylene Dibromide	Waldo					1.3E-06	1.3E-06
Ethylene Dibromide	Aroostook	No 96 Emissions	1.3E-11			1.3E-06	1.3E-06
Ethylene Dibromide	Piscataquis					1.3E-06	1.3E-06
Ethylene Dibromide	Kennebec	No 96 Emissions				1.3E-06	1.3E-06
Ethylene Dibromide	Androscoggin	No 96 Emissions	1.6E-12			1.3E-06	1.3E-06
Ethylene Dibromide	Penobscot	No 96 Emissions	1.2E-12			1.3E-06	1.3E-06
Chloroform	Knox		2.1E-08			1.3E-06	1.3E-06
Ethylene Dichloride	York	No 96 Emissions	9.9E-11			1.3E-06	1.3E-06
Ethylene Dichloride	Franklin		2.9E-11			1.3E-06	1.3E-06
Ethylene Dichloride	Sagadahoc	No 96 Emissions	4.9E-10			1.3E-06	1.3E-06
Ethylene Dichloride	Cumberland	2.3E-11	2.9E-10			1.3E-06	1.3E-06
Ethylene Dibromide	York	No 96 Emissions	1.2E-11			1.3E-06	1.3E-06
Ethylene Dibromide	Franklin					1.3E-06	1.3E-06
Ethylene Dibromide	Sagadahoc	No 96 Emissions	2.4E-12			1.3E-06	1.3E-06
Ethylene Dichloride	Washington		5.5E-11			1.3E-06	1.3E-06
Ethylene Dichloride	Hancock	1.2E-10	6.9E-11			1.3E-06	1.3E-06
Ethylene Dichloride	Somerset	No 96 Emissions	2.5E-12			1.3E-06	1.3E-06
Ethylene Dibromide	Cumberland	No 96 Emissions	3.8E-12			1.3E-06	1.3E-06

Pollutant	County	Point ILCR 2005	Area ILCR 2005	Onroad Mobile ILCR 2005	Nonroad Mobile ILCR 2005	Back-ground ILCR 2005	Total ILCR 2005
Ethylene Dibromide	Hancock					1.3E-06	1.3E-06
Chloroform	Oxford	2.5E-08	2.8E-08			1.2E-06	1.3E-06
Ethylene Dibromide	Washington		4.4E-12			1.3E-06	1.3E-06
Ethylene Dichloride	Lincoln		5.5E-11			1.3E-06	1.3E-06
Ethylene Dibromide	Somerset	No 96 Emissions				1.2E-06	1.2E-06
Ethylene Dibromide	Lincoln		3.8E-12			1.2E-06	1.2E-06
Polycyclic Organic Matter (Total)	Cumberland	8.7E-09	1.1E-06				1.1E-06
Ethylene Dichloride	Knox		2.2E-10			1.1E-06	1.1E-06
1,3-Butadiene	Cumberland	No 96 Emissions	4.6E-09	9.5E-07	1.7E-07		1.1E-06
Ethylene Dibromide	Knox		2.2E-09			1.1E-06	1.1E-06
Ethylene Dichloride	Oxford		1.1E-10			1.1E-06	1.1E-06
Ethylene Dibromide	Oxford		5.7E-12			1.0E-06	1.0E-06

Table 11: Current Health Quotients Greater Than or Equal to 1 Posed by Individual Air Toxics on a County Wide Basis (Based upon Screening Risk Estimation Procedures)

Pollutant	County	Point HI 2005	Area HI 2005	On- road Mobile HI 2005	Non- road Mobile HI 2005	Back-ground HI 2005	Total HI 2005
Acrolein	Cumberland	0.0	0.4	0.7	0.3	0.0	1.4

5.2.5 Approximate County-Wide Risk from Mixtures of Air Toxics

The above calculations have updated potential risks for *individual* pollutants, but do not consider the effects of *mixtures* of air toxics on public health. Therefore, the benchmarking subcommittee also conducted an analysis of potential over-all risk at the county level posed by the mixture of the 31 urban HAPs assessed in the NATA, as roughly updated based on 2005 estimated emission values. For each county, the subcommittees summing carcinogenic risks, is shown in Table 12. In accordance with risk assessment guidance⁴¹, this analysis simplistically assumes that each of the carcinogens acts independently, and they are all additive.

⁴¹ This type of screening analysis is sometimes conducted by Risk Assessors. By way of example, this type of analysis is done by EPA for its NATA, and was conducted by MEDHHS when establishing its fish consumption advisories. Protocols for this type of assessment can be found in the State of Maine Department of Environmental Protection and Department of Human Services "Guidance Manual for Human Health Risk Assessments at Hazardous Substance Sites, (MEDEP, BRWM, State House Station 17, Augusta, ME 04333) June 1994; and EPA's 3-volume Air Toxics Risk Assessment Library under development by Roy Smith's group in Research Triangle Park; and other EPA guidance on the web at <http://cfpub.epa.gov/ncea/raf/recordisplay.cfm?deid=55907>; <http://www.epa.gov/ttn/atw/toxsource/summary.html>; <http://www.epa.gov/ncea/raf/car2sab/preamble.pdf>; and (<http://www.epa.gov/ttn/fera/>).

Table 12: Approximate Cancer Risks by Maine County in 2005 from 31 Urban Air Toxics, Based on the MATI Benchmarking Calculations

County	Point ILCR 2005	Area ILCR 2005	Onroad Mobile ILCR 2005	Nonroad Mobile ILCR 2005	Back-ground ILCR 2005	Total ILCR 2005	Total ILCR 2005 Less Background
Cumberland Total	4.6E-07	3.4E-06	7.1E-06	1.9E-06	1.9E-05	3.2E-05	1.3E-05
Sagadahoc Total	2.2E-09	4.0E-06	4.8E-06	2.8E-06	1.9E-05	3.1E-05	1.2E-05
Androscoggin Total	4.0E-07	3.2E-06	5.3E-06	1.1E-06	2.0E-05	3.0E-05	1.0E-05
Kennebec Total	1.0E-10	2.3E-06	3.6E-06	5.3E-07	2.0E-05	2.6E-05	6.4E-06
York Total	1.8E-07	1.6E-06	4.5E-06	5.8E-07	1.9E-05	2.6E-05	6.9E-06
Penobscot Total	2.1E-07	9.4E-07	2.5E-06	3.7E-07	2.0E-05	2.4E-05	4.0E-06
Waldo Total		8.8E-07	1.2E-06	9.3E-07	2.0E-05	2.3E-05	3.0E-06
Hancock Total	1.0E-06	5.0E-07	1.0E-06	3.6E-07	1.9E-05	2.2E-05	2.9E-06
Aroostook Total	7.8E-08	2.0E-07	5.3E-07	2.1E-07	2.0E-05	2.1E-05	1.0E-06
Piscataquis Total		9.7E-08	2.9E-07	4.2E-07	2.0E-05	2.1E-05	8.0E-07
Lincoln Total		6.2E-07	1.2E-06	7.1E-07	1.8E-05	2.1E-05	2.5E-06
Franklin Total	3.5E-07	1.5E-07	5.3E-07	5.1E-07	1.9E-05	2.1E-05	1.5E-06
Somerset Total	8.5E-08	6.9E-07	8.0E-07	3.5E-07	1.9E-05	2.1E-05	1.9E-06
Washington Total	3.6E-08	1.3E-07	3.2E-07	2.4E-07	1.9E-05	2.0E-05	7.3E-07
Knox Total		6.2E-07	1.1E-06	6.8E-07	1.7E-05	1.9E-05	2.4E-06
Oxford Total	7.2E-07	3.3E-07	7.5E-07	1.9E-07	1.6E-05	1.8E-05	2.0E-06

The approximate ILCR estimates shown in Table 12 indicate that when carcinogenic risks from background concentrations of pollutants are *not* included, 14 counties exceed the 1 in a million ILCR, and three (3) exceeded a 1 in 100,000 ILCR. When background concentrations are included, all counties exceed a 1 in 100,000 ILCR

The results of updating risks to 2005 emission values, and then summing non-carcinogenic risks, is shown in Table 13. The shaded cells in this table indicate non-cancer risks that exceed a Health Index (HI) of one (1), on a county-wide basis. Some small areas of the county that are close to emission sources will likely have a much higher non-cancer risk, and most areas will have a lower risk. It should be noted that this approach of summing all non-carcinogens is a conservative approach to assessing county-wide risk. The next step in a risk screening procedure such as this would be to sum compounds having similar toxicity endpoints.

Table 13: Approximate Non-cancer Risks by Maine County in 2005 From 31 Urban Air Toxics, Based on the MATI Benchmarking Calculations

County	Point HI 2005	Area HI 2005	On- road Mobile HI 2005	Non- road Mobile HI 2005	Back- ground HI 2005	Total HI 2005	Total HI 2005 less Background
Cumberland Total	0.0	0.4	0.7	0.3	0.0	1.5	1.5
Sagadahoc Total	0.0	0.3	0.6	0.1	0.0	1.0	1.0
Androscoggin Total	0.0	0.2	0.4	0.3	0.0	1.0	1.0
Kennebec Total	0.8	0.0	0.1	0.0	0.0	1.0	0.9
York Total	0.0	0.2	0.4	0.1	0.0	0.7	0.7
Penobscot Total	0.0	0.2	0.3	0.1	0.0	0.6	0.5
Waldo Total	0.0	0.1	0.3	0.1	0.0	0.4	0.4
Hancock Total		0.1	0.2	0.1	0.0	0.4	0.3
Aroostook Total		0.1	0.2	0.1	0.0	0.4	0.3
Piscataquis Total		0.1	0.1	0.1	0.0	0.3	0.3
Lincoln Total	0.0	0.0	0.1	0.1	0.0	0.3	0.2
Franklin Total	0.0	0.0	0.1	0.1	0.0	0.2	0.2
Somerset Total	0.0	0.0	0.1	0.0	0.0	0.2	0.2
Oxford Total		0.0	0.0	0.1	0.0	0.2	0.1
Washington Total	0.0	0.0	0.0	0.0	0.0	0.2	0.1
Knox Total		0.0	0.1	0.0	0.0	0.1	0.1

These approximate non-cancer risk estimates indicate that three (3) counties equal or exceed an aggregate HI of 1, whether or not background concentrations of pollutants are included, and another exceeds a HI of 1 when considering background concentrations.

5.3 Use of Benchmarking Calculations in the Development of the ATPL

One (1) compound shown in Table 11 exceeded a HI of 1 on a county-wide basis by itself, even when excluding background concentrations. This compound was added to the Air Toxics Priority List:

- acrolein

In addition to acrolein, six (6) individual pollutants exceed a 1 in a million ILCR on a county-wide basis due to current emissions. As discussed in detail in section 5.2.5 above and shown in Table 12, when summing ILCR from the 31 NATA pollutants in each county, most counties exceed a 1 in 100,000 ILCR, even when individual pollutants did not exceed this threshold. The additive nature of the carcinogenic risks from individual pollutants contributes to overall county risks exceeding an ILCR of 1 in 100,000. Some ATAC members believe that, contingent on feasibility, it may be appropriate to reduce overall risks to below 1 in 100,000, and that these pollutants posing a lesser risk must be addressed in order to achieve that goal. Further, the risk analysis described above is a screening level analysis aimed at determining which pollutants should not be considered further, thus it is appropriate to have a lower “acceptable risk” threshold at this stage. Other ATAC members do not agree that

overall county risks exceeding an ILCR of 1 in 100,000 creates an unacceptable risk that must be addressed. However, these members do believe that in localized hot-spots within the county, these same compounds may pose a much greater risk than the risk calculated on the county level, and so they should not be excluded from the ATPL at this point. Therefore, six (6) pollutants that coincidentally exceed an ILCR of 1 in a million due to current emissions were added to the list as follows:

- Benzene
- 1,3-Butadiene
- Formaldehyde
- Nickel
- Perchloroethylene
- POM

5.3.1 Consideration of Compounds Not Included in the NATA Assessment

As described earlier, the 1996 NATA only calculated the risk from 31 compounds. Therefore, while the ATAC assessed the relative risk from 148 air toxics based on toxicity-weighted emissions, it could only directly assess the risk posed by 31 compounds. However, once the NATA risks were updated, the benchmarking subcommittee was able to compare those compounds in Table 10 and Table 11 that exceeded a screening risk level (either considering county-wide risk of air toxic mixtures or the effects of localized hot-spots) to the list of toxicity-weighted emissions. This comparison is shown in Table 14.

Table 14: Preliminary Comparison of the Toxicity-Weighted-Emissions and Benchmarking-Risk-Approximations for Each Air Toxic

Toxicity-Weighted Rank	Pollutant Category	Toxicity-Weighted Emissions (unitless)	% of Total Tox - Weight	Above HI=1 or ILCR=1e-6 in Updated NATA?	Above HI=1 or ILCR=1e-5 in Updated NATA?
1	Acrolein	16,361,357,067	66.1%	Yes	Yes
2	POM	1,614,157,699	6.5%	Yes	No
3	Manganese	1,168,475,039	5%	No	No
4	Formaldehyde	986,993,386	4%	Yes	No
5	Nickel	956,885,478	4%	Yes	No
6	1,3-Butadiene	760,650,004	3%	Yes	No
7	Diesel PM	692,367,120	3%		
8	2,4-Toluene Diisocyanate	552,769,351	2%		
9	Sulfuric Acid	315,805,000	1%		
10	Benzene	174,286,869	1%	Yes	No
11	Acetaldehyde	132,014,898	1%	Yes	No
12	Lead	124,323,868	1%	No	No
13	Cadmium	110,647,841	0.4%	No	No
14	Methyl Bromide	100,173,587	0.4%		
15	Chlorine	90,942,800	0.4%		
16	Hydrochloric Acid	89,637,039	0.4%		
17	Chlorine Dioxide	80,424,000	0.3%		
18	Toluene	58,657,863	0.2%		
19	Dioxins	54,531,144	0.2%		

Toxicity- Weighted Rank	Pollutant Category	Toxicity- Weighted Emissions (unitless)	% of Total Tox - Weight	Above HI=1 or ILCR=1e- 6 in Updated NATA?	Above HI=1 or ILCR=1e- 5 in Updated NATA?
20	Chromium	41,391,854	0.2%	No	No
21	Arsenic	40,437,761	0.2%	No	No
22	Cyanide & Compounds	36,710,735	0.1%		
23	Glycol Ethers	26,018,401	0.1%		
24	Hydrogen Fluoride	22,240,551	0.1%		
25	Ammonia	18,902,531	0.1%		
26	1,3-Dichloropropene	18,043,801	0.1%	No	No
27	Hexane	16,894,581	0.1%		
28	Xylenes (Mixture of o, m, and p Isomers)	16,780,316	0.1%		
29	Chloroform	14,182,195	0.1%	Yes- Background	No
30	Selenium	10,643,039	0.04%		
31	Tetrachloroethylene (Perchloroethylene)	10,589,465	0.04%	Yes- Background	No
32	Cobalt	6,628,084	0.03%		
33	Beryllium	4,471,590	0.02%	No	No
34	4,4'-Methylenediphenyl Diisocyanate	3,831,399	0.02%		
35	Ethylene Glycol	3,740,673	0.02%		
36	Hydrogen Sulfide	3,379,310	0.01%		
37	Ethyl Benzene	2,843,039	0.01%		
38	Methyl Ethyl Ketone	2,687,438	0.01%		
39	2,2,4-Trimethylpentane	2,523,168	0.01%		
40	Mercury	2,519,927	0.01%	No	No
41	Methyl Isobutyl Ketone	2,431,850	0.01%		
42	Methylene Chloride	2,038,792	0.01%	No	No
43	Trichloroethylene	1,622,606	0.01%	No	No
44	Propionaldehyde	1,510,355	0.01%		
45	Methyl Tert-Butyl Ether	1,455,147	0.01%		
46	Methanol	1,327,959	0.01%		
47	Butyl Cellosolve	1,280,759	0.01%		
48	Methyl Chloroform	940,823	0.004%		
49	Styrene	818,361	0.003%		
50	N,N-Dimethylformamide	806,865	0.003%		
51	Phenol	779,124	0.003%		
52	1,4-Dichlorobenzene	776,278	0.003%		
53	Acrylonitrile	566,840	0.002%	No	No
54	Propylene Oxide	393,244	0.002%		
55	Maleic Anhydride	380,568	0.002%		
56	Acrylic Acid	358,093	0.001%		
57	Methyl Chloride	321,554	0.001%		
58	1,2,4-Trichlorobenzene	317,414	0.001%		
59	Triethylamine	273,305	0.001%		
60	Cumene	249,529	0.001%		
61	Barium	206,475	0.001%		
62	Biphenyl	195,255	0.001%		
63	Chlorobenzene	162,117	0.001%		
64	Antimony	154,240	0.001%		
65	Cresol	137,219	0.001%		

Toxicity- Weighted Rank	Pollutant Category	Toxicity- Weighted Emissions (unitless)	% of Total Tox - Weight	Above HI=1 or ILCR=1e- 6 in Updated NATA? Yes- Background	Above HI=1 or ILCR=1e- 5 in Updated NATA? No
66	Carbon Tetrachloride	103,334	0.0004%		
67	Ethylene Oxide	85,528	0.0003%	No	No
68	Aniline	80,333	0.0003%		
69	Ethylene Dichloride	75,688	0.0003%	Yes- Background	No
70	2-Nitropropane	69,551	0.0003%		
71	1,2,4-Trimethylbenzene	52,000	0.0002%		
72	Chloroprene	47,564	0.0002%		
73	N,N-Dimethylaniline	46,636	0.0002%		
74	Chloromethyl Methyl Ether	43,026	0.0002%		
75	Methyl Methacrylate	37,931	0.0002%		
76	Phosphorus & Compounds	37,056	0.0001%		
77	Cellosolve Solvent	29,600	0.0001%		
78	Allyl Chloride	24,755	0.0001%		
79	Catechol	21,667	0.0001%		
80	Carbon Disulfide	20,808	0.0001%		
81	2,4,6-Trichlorophenol	20,680	0.0001%		
82	Diethanolamine	19,828	0.0001%		
83	2,4-Dinitrotoluene	19,160	0.0001%		
84	Vinylidene Chloride	16,601	0.0001%		
85	Propylene Dichloride	16,404	0.0001%	No	No
86	Carbonyl Sulfide	15,912	0.0001%		
87	Phosphorus	13,574	0.0001%		
88	PCBs	13,350	0.0001%	No	No
89	Epichlorohydrin	12,309	0.00005%		
90	Vinyl Chloride	10,308	0.00004%	No	No
91	Cellosolve Acetate	10,246	0.00004%		
92	Ethylene Dibromide	9,314	0.00004%	Yes- Background	No
93	1,1,2,2-Tetrachloroethane	9,255	0.00004%	No	No
94	Vinyl Acetate	8,488	0.00003%		
95	ZINC	8,467	0.00003%		
96	Hydrazine	7,895	0.00003%	No	No
97	Acetonitrile	6,266	0.00003%		
98	Isophorone	5,799	0.00002%		
99	Nitrobenzene	5,623	0.00002%		
100	Bis(2-Ethylhexyl)Phthalate	5,580	0.00002%		
101	Bis(Chloromethyl)Ether	4,811	0.00002%		
102	Hexachlorocyclopentadiene	4,738	0.00002%		
103	Acrylamide	4,461	0.00002%		
104	Dibutyl Phthalate	3,539	0.00001%		
105	Quinoline	3,230	0.00001%		
106	Ethyl Acrylate	3,204	0.00001%		
107	Titanium Tetrachloride	3,145	0.00001%		
108	Acetophenone	2,759	0.00001%		
109	Ethyl Chloride	2,172	0.00001%		
110	Benzyl Chloride	1,886	0.00001%		
111	o-Anisidine	1,842	0.00001%		
112	Benzotrichloride	1,775	0.00001%		
113	p-Dioxane	1,654	0.00001%		

Toxicity- Weighted Rank	Pollutant Category	Toxicity- Weighted Emissions (unitless)	% of Total Tox - Weight	Above HI=1 or ILCR=1e- 6 in Updated NATA?	Above HI=1 or ILCR=1e- 5 in Updated NATA?
114	1,2-Propylenimine	1,398	0.00001%		
115	Dimethyl Sulfate	1,226	0.00000%		
116	Ethylidene Dichloride	1,009	0.00000%		
117	Xylene	942	0.00000%		
118	Phthalic Anhydride	818	0.00000%		
119	Quinone	637	0.00000%	No	No
120	o-Toluidine	523	0.00000%		
121	Methyl Isocyanate	513	0.00000%		
122	Methyl Iodide	435	0.00000%		
123	Hexachlorobenzene	239	0.00000%	No	No
124	4,4'-Methylenedianiline	221	0.00000%		
125	Diethyl Sulfate	160	0.00000%		
126	Phosgene	127	0.00000%		
127	1,1,2-Trichloroethane	41	0.00000%		
128	Hydroquinone	40	0.00000%		
129	Pentachlorophenol	39	0.00000%		
130	Dichloroethyl Ether	24	0.00000%		
131	Chloroacetic Acid	23	0.00000%		
132	Vinyl Bromide	22	0.00000%		
133	Acetamide	21	0.00000%		
134	Dichlorvos	19	0.00000%		
135	1,1-Dimethyl Hydrazine	18	0.00000%		
136	Hexachlorobutadiene	7	0.00000%		
137	4,6-Dinitro-o-Cresol	6	0.00000%		
138	Dibenzofuran	6	0.00000%		
139	4-Nitrophenol	4	0.00000%		
140	Heptachlor	3	0.00000%		
141	Pentachloronitrobenzene	3	0.00000%		
142	Chlordane	2	0.00000%		
143	Methylhydrazine	1	0.00000%		
144	Captan	0.4	0.00000%		
145	3,3'-Dichlorobenzidene	0.3	0.00000%		
	2,4-Dichlorophenoxy Acetic				
146	Acid	0.3	0.00000%		
147	p-Phenylenediamine	0.2	0.00000%		
148	Carbaryl	0.1	0.00000%		
149	2,4-Dinitrophenol	0.01	0.00000%		
150	Dimethyl Phthalate	0.003	0.00000%		
151	Trifluralin	0.003	0.00000%		
152	Hexachloroethane	0.001	0.00000%		
153	Styrene Oxide	0.0001	0.00000%		
	Grand Total	24,751,122,967	100%		

With the exception of Manganese, the updated risk estimations from section 5.2.4 showed that compounds ranked above 11, contributed to county-wide, ILCRs greater than 1 in 100,000 or a HI of 1. At small localized hot-spots within the county, it is possible that these compounds, on an individual basis, exceed ILCRs greater than 1 in 100,000 or a HI of 1. Therefore, the following compounds for which no NATA information was available, but that ranked higher than number 11 on the toxicity-

weighted inventory were added to the ATPL. They were added in order of their toxicity-weighted emissions:

- Diesel PM
- 2,4-Toluene Diisocyanate
- Sulfuric Acid

6. OTHER FACTORS CONSIDERED IN THE DEVELOPMENT OF THE ATPL

The Air Toxics Priority List developed in Section 5 above was based on toxicity-weighted emission estimates and rough estimates of actual risk. Several other factors were considered by the ATAC in developing the priority list, and the list was modified based on these factors as discussed below.

6.1 Persistence in the Environment

There is great variation in the speed with which compounds will degrade once emitted into the biosphere. Some will last a matter of minutes, and others will remain for several decades. Those compounds that do not readily degrade will remain in the biosphere such that emissions from each inventory year become additive. The toxicity-weighted emissions in section 4 above do not take this persistence into account.

The ATAC explored simplistic factors, such as an Air Toxic's half-life in air, to account for persistence. However, many chemical properties and weather conditions affect a chemical's residence time in the atmosphere. Furthermore, other compounds, particularly metals, may not remain in the atmosphere, but will remain in terrestrial or aquatic ecosystems once deposited. A sophisticated modeling of all of these factors is beyond the scope of this project, a simplified protocol was not readily available to quantify persistence, and quantification of persistence needlessly complicated the ranking of air toxics. Rather, the ATAC accounted for persistence in a qualitative manner, as described below.

6.1.1 Chloroform, Carbon Tetrachloride, Ethylene Dichloride and Ethylene Dibromide

The updated NATA Risk (see section 5.3 above) suggested that four compounds may currently exceed ILCR of 1 in a million on a county level, yet the four had relatively low toxicity-weighted emissions. These four compounds, Chloroform, Carbon Tetrachloride, Ethylene Dichloride and Ethylene Dibromide (see Table 14), are persistent in the atmosphere and therefore the risk is determined by historic emissions, rather than current emissions. The ATAC added these to the ATPL, since in the solutions stage of the MATI, the ATAC should consider ways to reduce emissions. However, careful consideration must be given to the cost and effectiveness of emission reduction efforts, since much of the risk is derived from historic, rather than current emissions.

6.1.2 Inorganic Compounds

Likewise, due to their persistence in the environment, and relatively high toxicity-weighted scores, the ATAC believes that it is appropriate to add several inorganics to

the ATPL. Again, the 1996 NATA only considered inhalation exposures, and not other exposure pathways that may come into play once a compound is deposited on land surfaces or into water bodies. The inorganics added are shown in Table 15.

Table 15: Inorganic Compounds Added to the ATPL Due to High Persistence

Toxicity- Weighted Rank	Compound
3	Manganese
12	Lead
13	Cadmium
20	Chromium
21	Arsenic
22	Cyanide & Compounds

6.2 Bioaccumulation

Some chemicals will increase in concentration over time when they are eaten, absorbed or breathed into an animal. This is called “bioconcentration” or “bioaccumulation”. Bioconcentration occurs whenever an animal’s tissue absorption level of a chemical exceeds the rate of metabolism (breakdown) and excretion of that chemical. Thus, over time, an animal may have a greater concentration of the contaminant in its tissue than the surrounding contaminated environment. Further, as these animals are eaten by predators, the predator will be eating highly contaminated tissue. In this way, there, so there is greater exposure to the contaminant when moving up the food chain. Dioxin, and methyl- mercury are two compounds that are know to be highly bioaccumulative. Often these compounds will concentrate in the fatty tissue of an animal.

Bioconcentration is an important property of an AT’s risk that was not quantified in the Toxicity-Weighting approach taken in section 4 above, nor was this factor included in the 1996 NATA Risk Assessments. The ATAC explored simplistic factors, such as Bioconcentration Factors (BCFs)⁴², to account for bioaccumulation, but determined that a meaningful, simplified protocol was not readily available. Many factors influence the movement of these compounds through the environment, and a sophisticated modeling of all of these factors is beyond the scope of this project. Therefore, the ATAC determined that it was more appropriate to qualitatively assess bioaccumulation, rather than try to quantify the impacts in Maine’s air toxics ranking scheme.

Due to the multiple exposure pathways, bioaccumulative properties, and current body burdens, Dioxins and Mercury compounds were added to the ATPL.

⁴²Bioconcentration Factors (BCFs) are used to describe the accumulation of chemicals in organisms, primarily aquatic, that live in contaminated environments. BCFs are not generated for terrestrial animals that breathe contaminated air. Usually the route of exposure is through living in a contaminated aquatic environment and/or eating prey with highly contaminated tissue. Therefore, most BCFs are derived for aquatic environments and are not directly applicable to air. However, compounds such as PCBs, Dioxin, and mercury, once released into the air, can be deposited in aquatic ecosystems, and then enter the food chain. Bioaccumulation factors are available from a variety of sources. For a summary of available databases, see The Danish University of Pharmaceutical Sciences website at: http://www.dfh.dk/~fi/A316/datasoegning/Links/Links_body.htm.

Table 16: Compounds Added to the ATPL Due to High Bioaccumulation

Toxicity- Weighted Rank	Compound
19	Dioxins
40	Mercury
N/A	Brominated Flame Retardants

6.2.1 Dioxins

While Dioxin is typically not found in high concentrations in the ambient air, deposition of these compounds can have significant impacts on public health, since these compounds are very persistent and bioaccumulate. 2, 3, 7,8 TCDD is also one of the most toxic compounds found in the environment. Recent information suggests that existing body burdens in the United States are at or above acceptable risk levels. While these risk levels are mainly due to levels of dioxin in food⁴³, the ATAC retained Dioxin on the list since the ATAC should explore ways to reduce the amount of dioxin entering the biosphere.

6.2.2 Mercury

Blood-mercury levels in 8% of Maine Women are high enough to cause fetal damage; impairing the child's fine motor, language, visual-spatial (e.g. drawing) and verbal memory skills, as well as its cardiovascular, immune and reproductive systems.⁴⁴ High levels of mercury in fish have also prompted fish consumption advisories from DHS. These advisories are at odds with our efforts to promote tourism, aquaculture, and healthier eating habits to reduce the number 1 health problem in Maine; heart disease. Some of the highest mercury levels in fish, loons and eagles in the US are found in Maine. For these reasons, mercury is a serious public health, economic, and environmental problem for Maine.

In the past 5 years Maine has moved aggressively to reduce mercury emissions in the state and regionally. Maine is also a national leader in removing mercury from commercial products and the waste stream. Much of the current mercury problem stems from out-of-state air emissions: Measurements of mercury in rain falling on Maine indicate that the State/Regional reduction efforts need to be supplemented by national

⁴³ USEPA, "Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin (TCDD) and Related Compounds, National Academy Sciences (NAS) Review Draft, Part III: Integrated Summary and Risk Characterization for 2,3,7,8-Tetrachlorodibenzo-*p*-Dioxin (TCDD) and Related Compounds (National Center for Environmental Assessment)" (*Research and Development*, U.S. Environmental Protection Agency, Washington, DC, available at: (http://www.epa.gov/ncea/pdfs/dioxin/nas-review/pdfs/part3/dioxin_pt3_full_oct2004.pdf), December 2003)

⁴⁴Woodruff, Tracey J., Daniel A Axelrad, Amy D. Kyle, Onyemaechi Nweke, Gregory G. Miller; *America's Children and the Environment: Measures of Contaminants, Body Burdens and Illness*, 2nd Ed., US Environmental Protection Agency and National Center for Environmental Economics (EPA240-R-03-001,) February 2003, Pg 59.

efforts and international efforts to curb emissions drifting in from out-of-state.⁴⁵ While the issues surrounding mercury control can be difficult, the ATAC believes that it is important for Maine's economy and environment to continue these efforts. Due to the high degree of existing contamination in fish and continuing air transport into Maine, the ATAC added mercury to the Air Toxics Priority List.

6.2.3 Brominated Flame Retardants

Brominated Flame Retardants (BFRs) is the generic term for a group of compounds that includes polybrominated biphenyls (PBBs), polybrominated diphenyl ethers (PBDEs), Tetrabromobisphenol-A (TBBPA) and Hexabromocyclododecane (HBCD). These compounds are added to the foam plastics that are used in furniture, TVs, computers, and other products to reduce their ability to catch fire. The BFRs off-gas from these products. The MEDEP did not have emission estimates for these compounds, so ATAC was unable to quantify where they may fall on the Air Toxics Priority List. However, these compounds are persistent and tend to bioaccumulate in body tissue. Many of them have been banned from use in Europe and other states due to concerns about their toxicity. These compounds have been found to be widespread in the environment.⁴⁶ Recent analysis shows that PDBEs levels in the breast milk of Americans is up to 10 times higher than the concentrations in the breast milk of European women.⁴⁷ While these may turn out to be an indoor air rather than ambient air issue, the ATAC added these compounds to the Air Toxics Priority List because the ATAC believes that Brominated Flame Retardants warrant further investigation.

6.2.4 Additional Pollutants of Concern

Acetaldehyde, methyl bromide, chlorine, hydrochloric acid and chlorine dioxide were also added to the ATPL for the following reasons. Acetaldehyde was on the NATA list in 1996, is the 11th largest in terms of toxicity weighted emissions and is a major component of combustion. There is some uncertainty in emission factors for chlorine and hydrochloric acid from combustion between the values published in EPA's FIRE database, and the emission factors used by EPA in the boiler MACT. Chlorine and chlorine dioxide have been important in policy discussions for the last decade as they relate to the formation of dioxins, and thus were added to the list. Finally, Methyl bromide was added due its importance in the FIFRA related product category.

⁴⁵ Ryan, Patrick A., Hilary R. Hafner, Steven G. Brown; Deposition of Air Pollutants to Casco Bay By Sonoma Technology, Inc. for the Casco Bay Estuary Project, University of Southern Maine (USM, PO Box 9300, Portland, ME 04104-9300) July 3, 2003; and Saball, Douglas, et. al. Mercury Deposition in Maine: Status Report 2003 (Maine DEP, 17 SHS, Augusta, ME 04333) July 15, 2003.

⁴⁶ Hale, Robert C., Virginia Institute of Marine Science, "Occurrence of PBDE Flame Retardants in Fish" in The Proceedings from the National Forum on Contaminants in Fish, October 20-22, 2002, Burlington Vermont (US EPA and American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, Maryland 20814-2199) (http://www.epa.gov/waterscience/fish/forum/2002forum_complete.pdf)

⁴⁷ Schecter, Arnold, et. al. Polybrominated Diphenyl Ethers (PBDEs) in U.S. Mothers' Milk,. (Environmental Health Perspectives Volume 111, Number 14) November 2003.

7. GROUND TRUTHING USING AMBIENT AIR MONITORING DATA

As discussed in earlier sections, there are many areas of uncertainty underlying the inventory used in the 1996 NATA, the current inventory developed by the ATAC, the NATA modeling, and benchmarking process. Given this uncertainty, an important question arises as to whether or not the NATA modeling and subsequent ATAC benchmarking accurately predicts the risks posed by air toxics in Maine. An independent check on these risk estimations is to assess actual concentrations of air toxics in the ambient air, and their estimated risk. While it is beyond the scope of this prioritization phase to conduct Air Toxics Monitoring, Maine DEP already conducts extensive ambient air monitoring. Most of this monitoring is aimed at measuring criteria pollutants, but the ATAC was able to use portions of this data to assess ambient concentrations of HAPs.

7.1 Sources of HAP Monitoring Data

7.1.1 IMPROVE Data – Background Concentrations of Metals and Chlorine

The benchmarking subcommittee reviewed ambient air monitoring data for eight Air Toxics obtained in the IMPROVE program. IMPROVE is the Interagency Monitoring of Protected Visual Environments, a cooperative program between Federal and regional-state organizations, begun in 1985, to monitor pollutants that can impair visibility in Class I areas (156 national parks and wilderness areas).⁴⁸ MEDEP downloaded IMPROVE data from Maine and New Hampshire that had been published on the IMPROVE Website. This data had met the quality control standards established for the IMPROVE network, which is published on its website. IMPROVE sites have an aerosol sampler to measure select aerosols and PM. The IMPROVE sites are located to provide background concentrations of pollutants, in areas that will not be impacted by local emission sources⁴⁹.

⁴⁸ More Information is available from the IMPROVE website, at <http://vista.cira.colostate.edu/improve/Overview/Overview.htm>. According to the website, “The objectives of IMPROVE are:

(1) to establish current visibility and aerosol conditions in mandatory class I areas;
(2) to identify chemical species and emission sources responsible for existing man-made visibility impairment;
(3) to document long-term trends for assessing progress towards the national visibility goal;
(4) and with the enactment of the Regional Haze Rule, to provide regional haze monitoring representing all visibility-protected federal class I areas where practical.
IMPROVE has also been a key participant in visibility-related research, including the advancement of monitoring instrumentation, analysis techniques, visibility modeling, policy formulation and source attribution field studies.”

⁴⁹ “The site criteria fall into three categories: (1) the site must represent all the Class I areas in the cluster, (2) the site should be regionally representative, avoiding local pollution sources or areas with unusual meteorology, and (3) the site must avoid nearby obstacles that could affect sample collection” according to Crocker Nuclear Laboratory, University of California, in IMPROVE PARTICULATE MONITORING NETWORK PROCEDURES FOR SITE SELECTION (One Shields Avenue, Davis, CA 95616-8569, (530) 752-4106) February 24, 1999.
http://vista.cira.colostate.edu/improve/Publications/SOPs/ucdavis_sops/select22.pdf

7.1.2 BEAM Program – Mobile Source VOCs at Hot Spot Locations



The Breathing Easier Through Air Monitoring (BEAM) project collects real time air quality data in Portland Maine. The BEAM project uses a Differential Optical Absorption Spectroscopy (DOAS) Ultraviolet open path system to monitor real time air pollution levels in Portland. This system shoots a beam of light from an emitter on the roof of the University of Southern Maine Library, across Interstate 295, to a receiver in the commuter parking lot located at the corner of Preble Street and Marginal Way. The beam

measures the average pollutant concentration between the sending unit and receiver. The results therefore represent emission density plus initial dispersion within the area bounded by the monitor. The pollutants MEDEP is measuring include ozone, sulfur dioxide, nitrogen dioxide, benzene, toluene, total xylene, formaldehyde and phenol. The main purpose of the BEAM project is to make real-time pollutant concentration information readily available to the public, so pollutant concentrations are sent to the Internet hourly.⁵⁰ The ATAC, however, was able to use the monthly average benzene data to ascertain potential hot-spot benzene exposure to residents living near the interstate.

7.1.3 TO-15 Canister Monitoring Program – VOCs

Over the past 15 years, Maine DEP has obtained ambient air samples at various locations across the state, and analyzed them for volatile organic compounds. The samples were collected in canisters for a 24-hour period, every six days and then analyzed for a suite of volatile organic compounds, using what would become EPA method TO-14, and later the updated method of TO-15. These Methods contain many protocols to ensure that results accurately represent ambient concentrations of the pollutants that were sampled. The sampling locations are usually selected to monitor high impact sites, rather than background locations. Three laboratories were involved in the analysis of samples from these sites. MEDEP is still in the process of reviewing and publishing the final results of these sampling programs.

7.1.3.1 Early Sampling Efforts

In 1991 Maine DEP initiated an air toxics pilot project at two sites in the Rumford/Mexico area of Oxford County to measure HAP impacts from a nearby Point Source. The program was expanded in 1992 to four towns (10 sites) in southern Maine, two towns (five sites) Downeast, and one town (5 sites) in

⁵⁰ Maine DEPs Bureau of Air Quality web page on 7/27/05, located at: <http://www.maine.gov/dep/air/beam/aboutbeam.htm> and Emery, Jeff, Report on Air Quality in the State of Maine, 1997-2000 (MEDEP, 17 SHS, Augusta, ME 04333) (undated).

central Maine, with the aim of determining concentrations at urbanized, rural and industrial sites. After DHHS determined that long-term exposure to the detected concentrations posed potential health risks, MEDEP obtained more samples in 1993 in the Rumford/Mexico area to confirm the concentrations. The canisters were not analyzed until late in 1995.

7.1.3.2 The Rumford/Mexico Sampling Program

Further samples were obtained in the Rumford/Mexico area between 1995 and 1999 at three sampling sites, which were established to detect high concentrations from a Point Source. The sites are in a valley with complex meteorology, which may have increased ambient levels of long-lived HAPs, and which made it impossible to establish a “background” monitoring site. In 2000, two of the three sites were shut down and the remaining site was kept in operation as a long-term trend site. The two monitors that were shut down in the Rumford/Mexico area were then used in the Portland area.

7.1.3.3 The Portland Sampling Program

In 1996 through 1997 MEDEP also sampled ambient air at five monitoring sites in the greater Portland area in both heavily urbanized and residential areas for volatile organic compounds. However, a number of processing problems invalidated most of the final results. Four sampling sites were established in the Portland area in 2000 and are operational today.

7.1.4 PAMS Network – Background Concentrations of VOCs and Meteorological Data

New England states are required by USEPA to establish Photochemical Assessment Monitoring Stations (PAMS) in areas that do not meet federal ozone standards. Ozone forms as a result of the interaction of photoreactive Volatile Organic Compounds (VOCs) and nitrogen oxides in the presence of sunlight. Therefore, each PAMS site collects data for ozone, oxides of nitrogen (NO, NO₂, NO_x, NO_y) and 54 photoreactive VOCs, including eight (8) HAPs: benzene, toluene, ethyl benzene, xylenes (including m&p xylene and o-xylene), isopropylbenzene (cumene), styrene, n-hexane and trimethylpentane. Additionally all sites collect surface meteorological data, while some also collect upper air meteorological data. PAMS samples are collected hourly during the peak of the ozone season, which is from June 1 to August 31 of each year.

There are four types of PAMS sites ranging from upwind background (Type 1), maximum emissions (Type 2), maximum ozone (Type 3) to extreme downwind (Type 4) locations. It's important to note that the definition of a given site type blurs since multiple emission sources exist along the eastern seaboard. Thus Cape Elizabeth is extreme downwind for Connecticut, but could also be considered a high ozone site for Boston.

The ATAC found that the PAMS data is useful for assessing ambient levels of select VOCs at background locations, as well as assessing the transport of HAPs into Maine

7.2 Background Concentrations of Metals and Chlorine in the Ambient Air

The benchmarking subcommittee reviewed ambient air monitoring data for eight Air Toxics obtained in the IMPROVE program. MEDEP downloaded IMPROVE data from Maine and New Hampshire that had been published on the IMPROVE Website. The IMPROVE sites are located to provide background concentrations of pollutants, in areas that will not be impacted by local emission sources. The information that was downloaded is shown in Figure 11 through Figure 18, and indicates that background concentrations of Arsenic, Chlorine, Chromium (Total), Copper, Lead, Manganese, Nickel, Selenium, and Zinc are all below Maine DHHS Ambient Air Quality Guidelines (below an ILCR of 1 in 100,000 and a HI of 1). It should be noted that the sample design of the IMPROVE system would only detect widespread exceedences (that were near national parks), and not local hot-spot exceedences.

Figure 11:

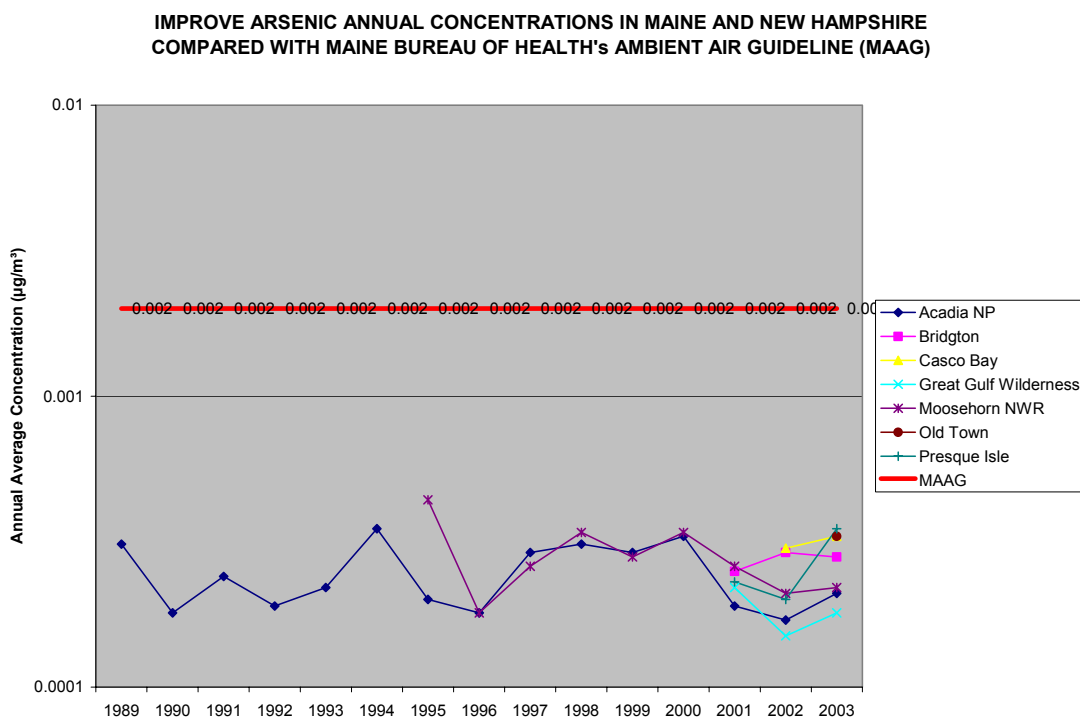


Figure 12

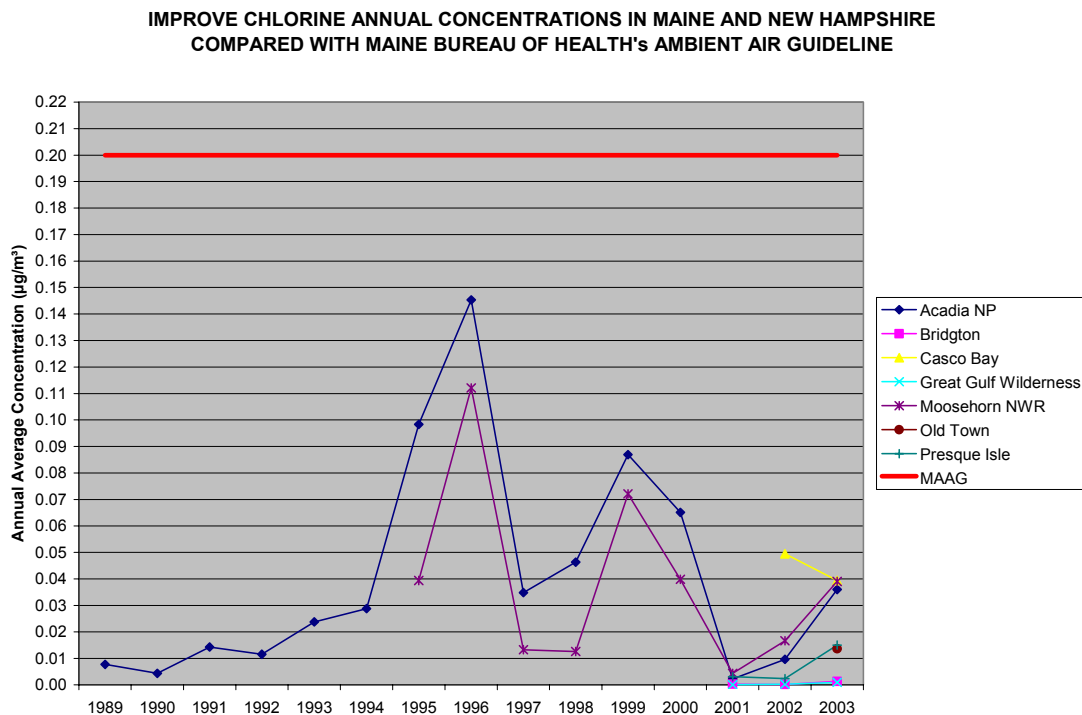


Figure 13

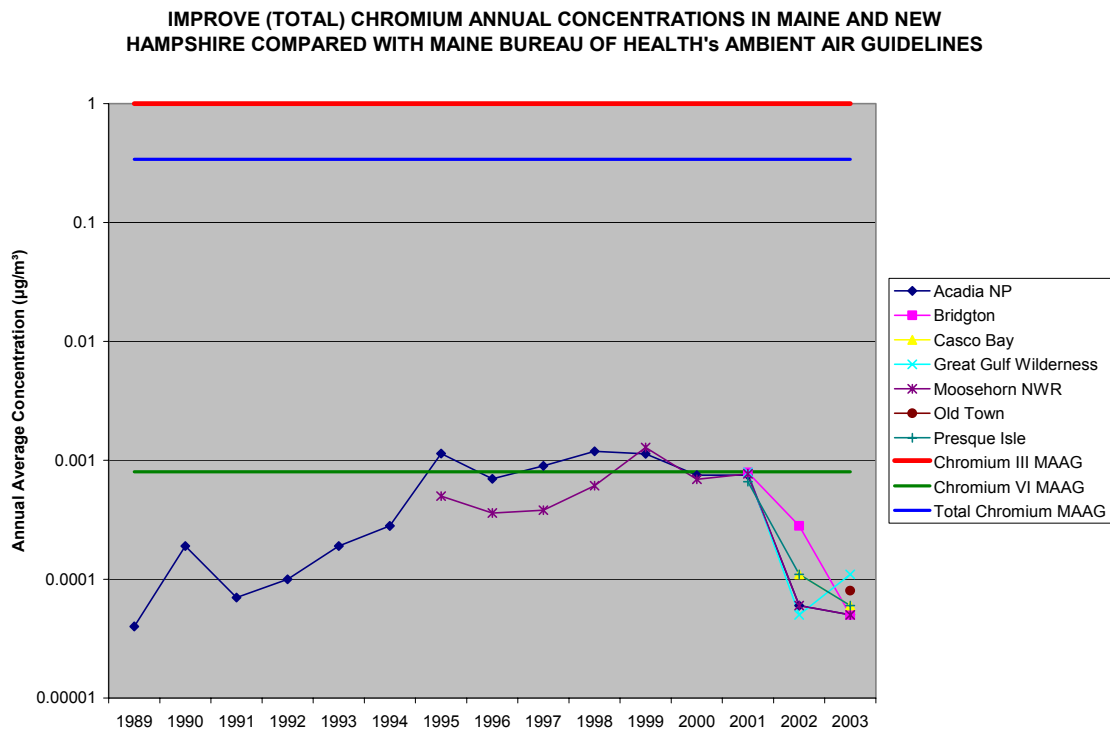


Figure 14:

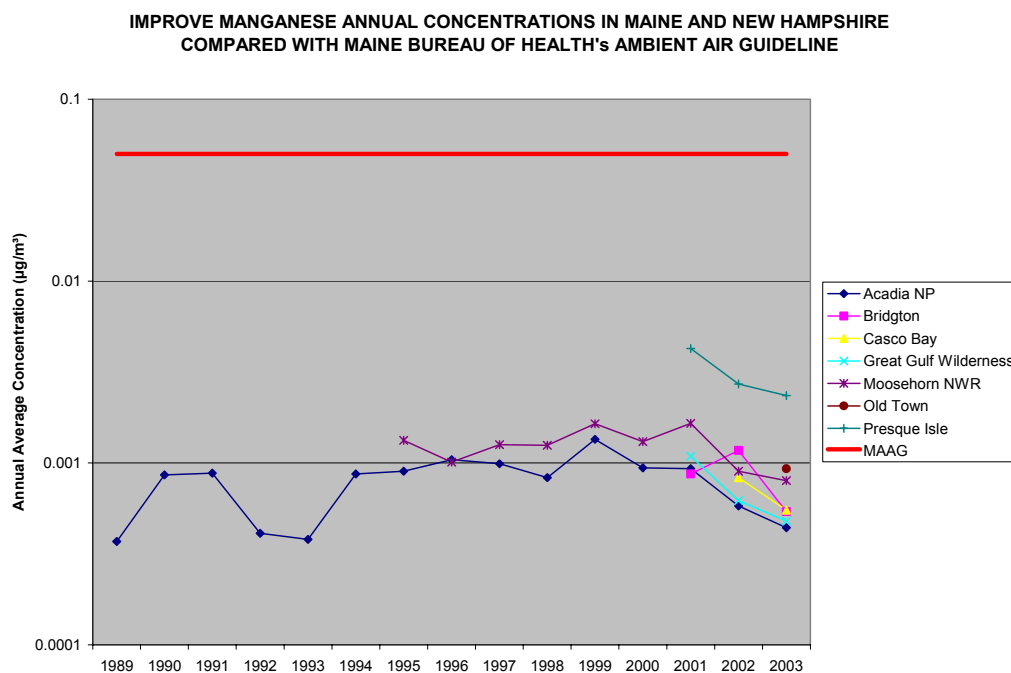


Figure 15:

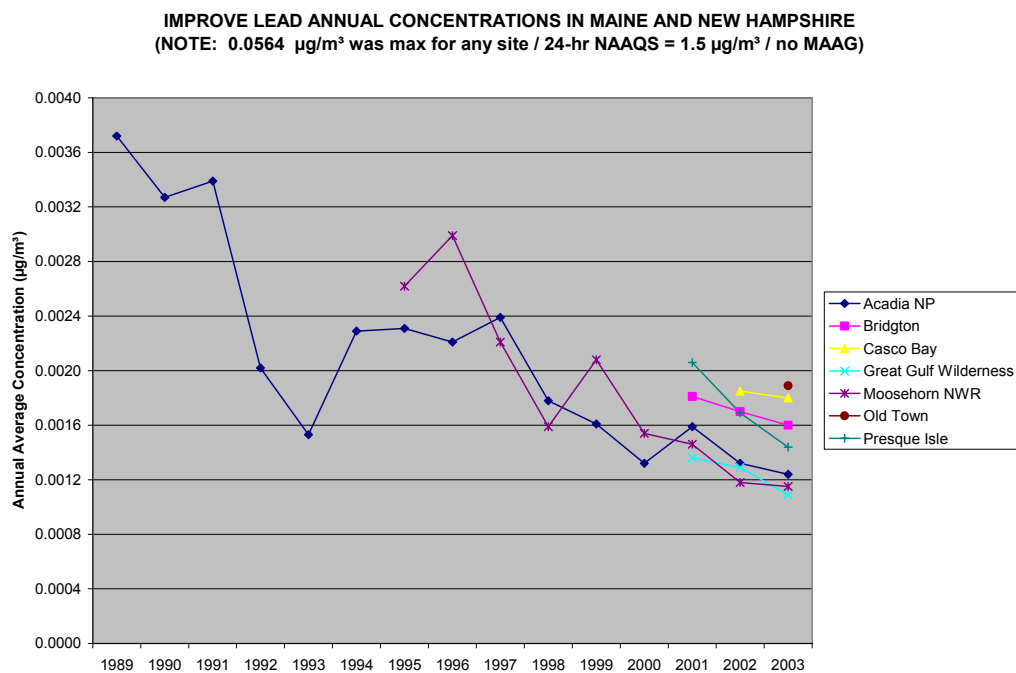


Figure 16:

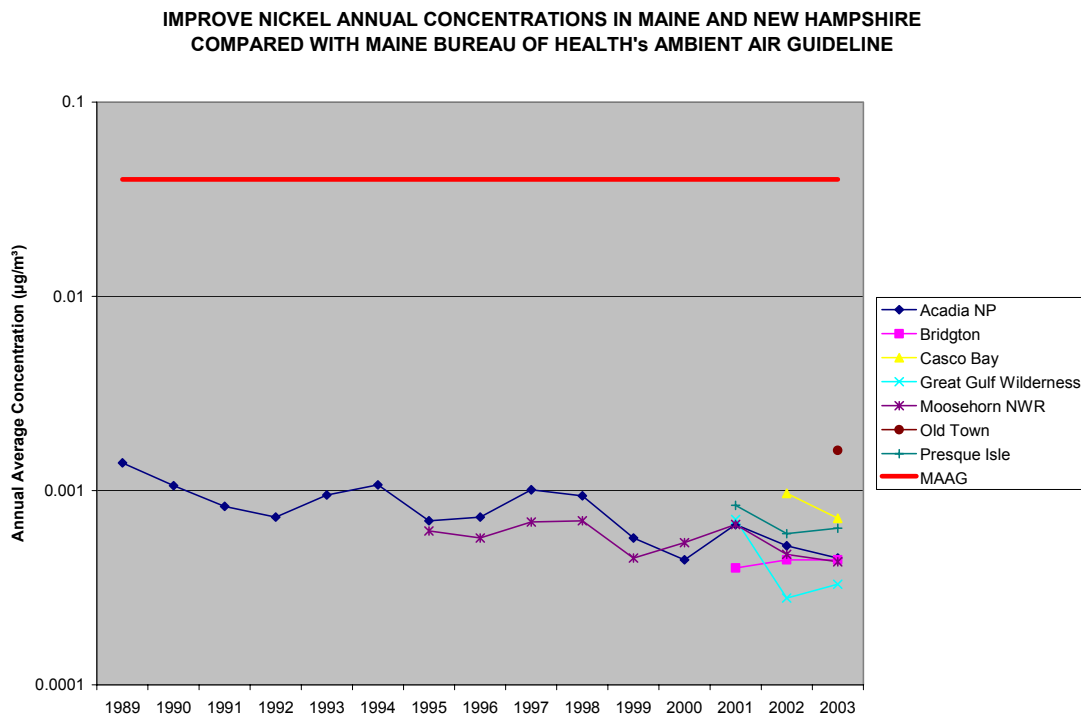


Figure 17:

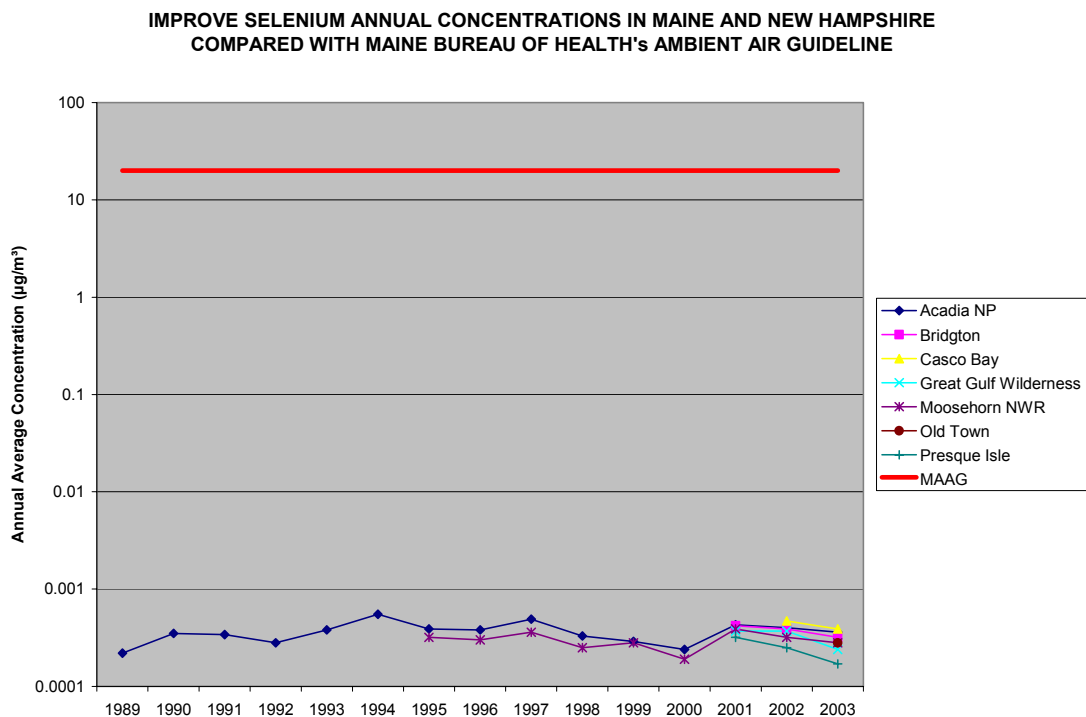
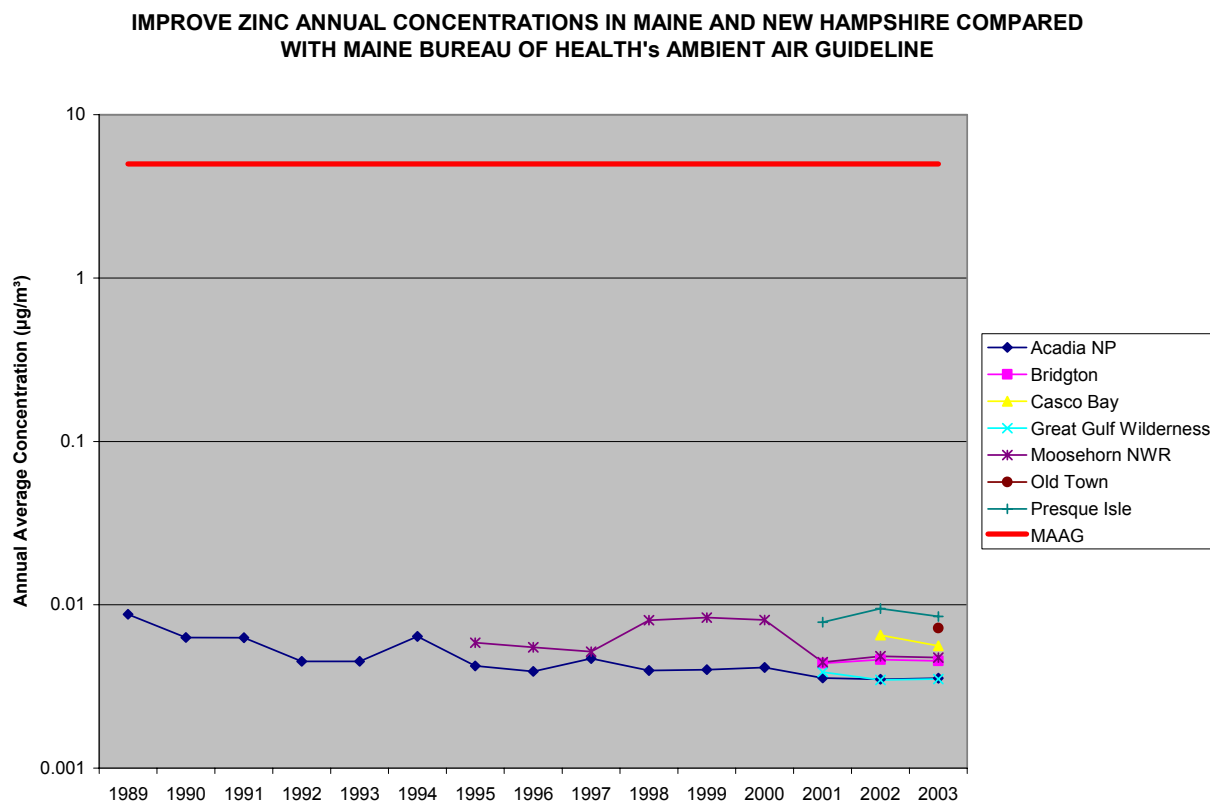


Figure 18:



7.3 Ambient Air Concentrations of Volatile Organic Compounds

7.3.1 Concentrations of VOCs at High Impact Sites

The 1991 Rumford pilot study detected ambient levels of chloroform; tetrachloroethylene; 1,3-butadiene; and benzene that if sustained over a long period would pose a risk greater than an ILCR of 1 in 100,000 and/or a HI of 1. The 1992 sampling found similar exposures across the state, with ME DHHS determining that long-term exposures to the monitored levels of benzene; 1,3-butadiene; carbon tetrachloride, and chloroform would pose risks above a Health Index of 1 and/or and Incremental Lifetime Cancer Risk of 1 in 100,000 in several Maine towns. MEDEP sampled Rumford for ATs again in 1993, and found that ambient levels of Chloroform had decreased below an ILCR of 1 in 100,000. The decline was attributed to decreased use of chlorine in a local paper mill. Otherwise, the results were consistent with the results of earlier studies.

Results of the long-term Air Toxics monitoring program in the Rumford area between 1998 and 2003 are averaged and compared to Maine Ambient Air Guidelines (MAAG), in Table 17. The results show that long-term exposure to the ambient levels of three different compounds would pose an incremental lifetime cancer risk (ILCR) that was in excess of 1 in 100,000. These compounds are benzene, 1,3 butadiene; and 1,2-

Dibromomethane. Ambient levels of twenty-six (26) compounds were determined to not pose a significant risk to public health. MEDEP was not able to determine the risk posed by air toxics that were not monitored, the risk posed by 23 compounds that were sampled but that lack risk-based ambient air guidelines, and 14 compounds whose detection limits are too high to enable measurement down to their low ambient air guideline levels. The MEDEP was particularly concerned about acrolein; 1,4 dichlorobenzene and 1,1,2,2-Tetrachloroethane, which have high detection limits, and so were rarely detected. However, in the instances that they were detected, they were well in excess of their respective MAAGs. Chloroform concentrations have decreased to levels below an ILCR of 1 in 100,000. These reductions are generally attributed to changes in chlorine use at the Rumford Papermill.

Table 17: Compounds of Concern That were Detected in Rumford Between 1998-2003

Monitoring Location	Compound	Average ND=1/2 RL (ug/m3)	Chronic AAG Cancer (ug/m3) @ 10E-5
Labonville	Benzene	1.03	1
Pumphouse I	Benzene	2.97	1
RAP-1	Benzene	1.08	1
RAP-1	1,3 Butadiene	0.34	0.3
Labonville	1,2-Dibromomethane	0.21	0.05
RAP-1	1,2-Dibromomethane	0.29	0.05
Pumphouse I	1,2-Dibromomethane	0.22	0.05

Sample results from the Portland area have not been published by MEDEP, and therefore were not available for review by the ATAC.

7.3.2 Background Concentrations of VOCs

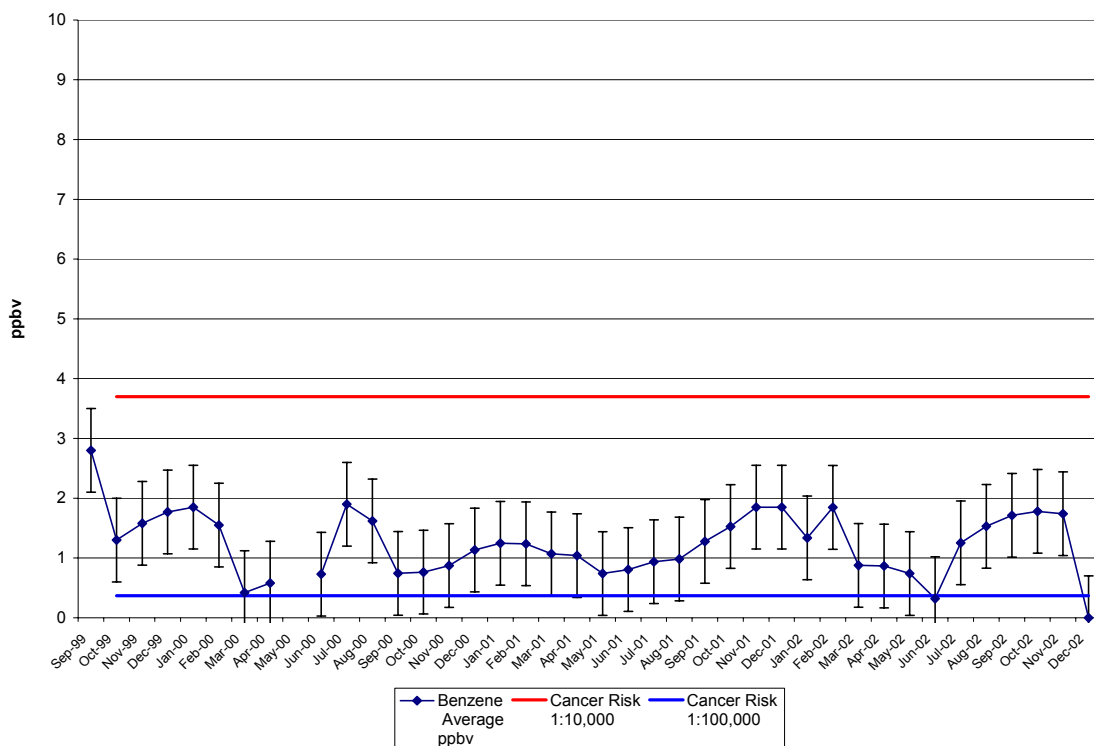
The ATAC reviewed the PAMS data relating to 8 photo-reactive VOCs that are also HAPs. The PAMS sites are established away from hot-spot locations, in order to monitor transport and background concentrations. Based on the PAMS data analysis, of the 8 HAPs monitored, only Benzene had concentrations anywhere near an ILCR of 1 in 100,000 or a HI of 1 (See Figure 25: Diurnal Benzene Trends (all days and ozone event days only) showing transport signals at Four New England PAMS sites). The ambient concentrations of toluene, ethyl benzene, xylenes (including m&p xylene and o-xylene), isopropylbenzene (cumene), styrene, n-hexane and trimethylpentane did not pose a risk above an ILCR of 1 in 100,000 or a HI of 1. Benzene concentrations are discussed further in section 7.4.3, and the use of PAMS data to assess HAP transport is discussed in section 7.5.4

7.4 Ambient Air Concentrations of Benzene

7.4.1 Near-Roadway Concentrations of Benzene

A historic plot of Benzene concentrations from the BEAM monitor is shown in Figure 19. The BEAM shoots across the interstate, where local emissions of benzene from Mobile sources are expected to be high. These results would be considered representative of near-roadway, hot-spot, exposures. This plot shows that long-term exposure to these concentrations would pose a cancer risk exceeding an Incremental Lifetime Cancer Risk of 1 in 100,000, but not exceeding the 1 in 10,000 level.

Figure 19: Monthly Averages vs. Cancer Risk of Benzene Between 1999 - 2002 as Measured by the Portland BEAM



7.4.2 Benzene at Impact Sites for Point & Mobile Sources

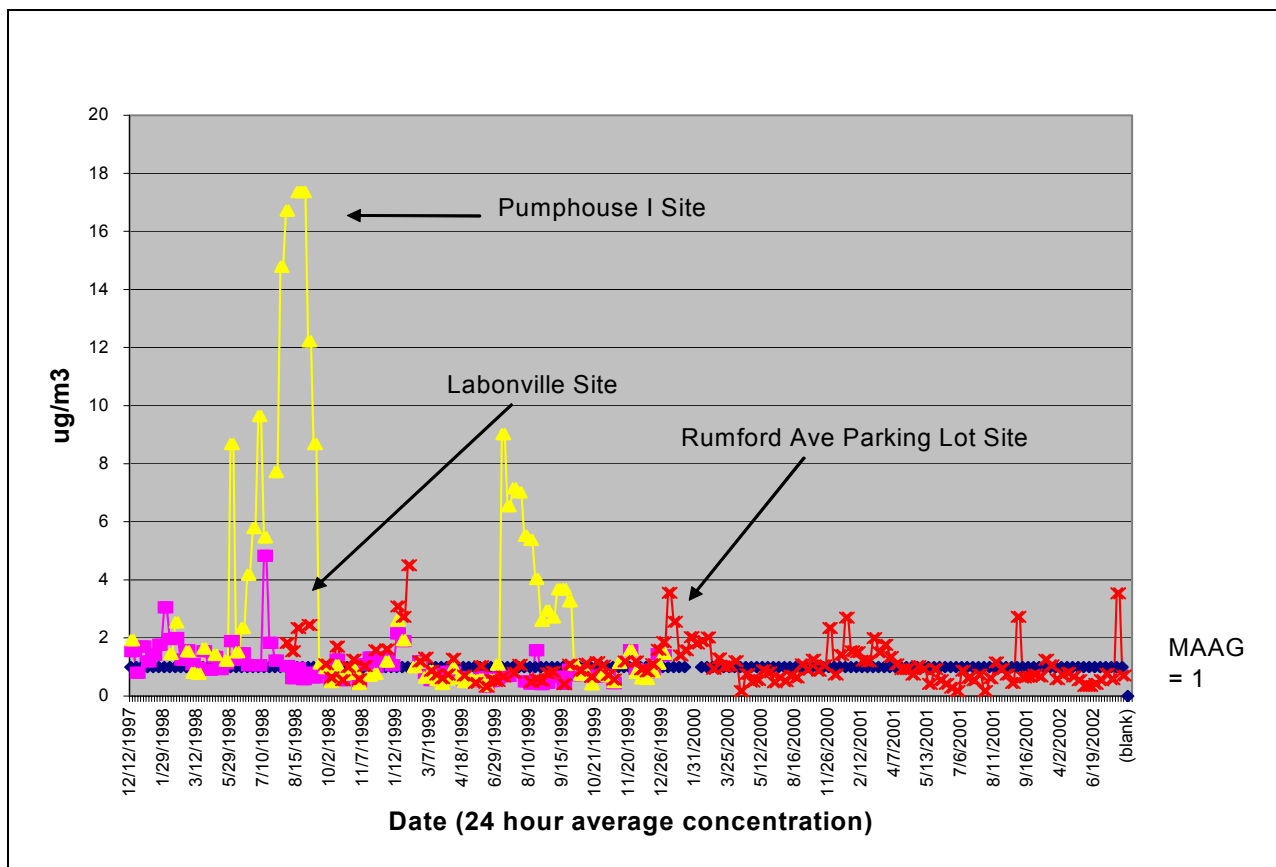
Figure 20 shows the concentration of benzene in the atmosphere at the three (3) monitoring locations in the Rumford Study area between 1997 and 2003 in relation to the DHS chronic ambient air guideline (MAAG)⁵¹, which was developed for a chronic

⁵¹ The information from this section was taken from

[http://www.state.me.us/dep/air/monitoring/Rumford HAPs Study \(draft-23p\).pdf](http://www.state.me.us/dep/air/monitoring/Rumford%20HAPs%20Study%20(draft-23p).pdf) a draft air toxics monitoring report that the DEP has distributed for public comment. The report is entitled, "Maine DEP's Ambient Air Toxics Monitoring Program in Rumford/Mexico, Maine 1997 – 2003, Revision of

exposure and is set at a 1 in 100,000 cancer risk level. These sample locations were established in areas that were expected to have high impacts from a Point Source. In retrospect, these locations were likely more impacted by mobile emissions of benzene. The average benzene concentration for these years was 2.97 $\mu\text{g}/\text{m}^3$ at the Pumphouse site, 1.08 $\mu\text{g}/\text{m}^3$ at the Rumford Avenue Parking lot site, and 1.03 $\mu\text{g}/\text{m}^3$ at the Labonville site.

Figure 20: 24 hour Average Concentration of Benzene at 3 sites in Rumford, Maine, 1997-2003



Note that the high Pumphouse average is driven by high concentrations early on in the study period. MEDEP assessed these high concentrations at the time, and ruled out laboratory or sampling error, but was unable to determine any usual activity that may account for these anomalies. These results indicate that persons chronically exposed

to these concentrations would have an ILCR greater than 1 in 100,000, but less than 1 in 10,000.

7.4.3 Background Concentrations of Benzene

The PAMS data was analyzed for benzene at two locations in Maine: The Cape Elizabeth site at Two Lights State Park, and the site located at the top of Cadillac mountain in Acadia National Park. These sites are located in areas that are not influenced by local emission sources. The results, shown in Figure 24, indicate that at background locations in Maine, benzene concentrations are below the 1 in 100,000 ILCR level.

7.5 Transport of Air Toxics into Maine

The ATAC sought to quantify the impacts from ATs that are transported into Maine from outside of the state. Transport is the source of a significant part of Maine's ozone problem⁵², and ATAC believes that it could be a significant source of Air Toxics to the state.

ATAC first looked to the 1996 NATA to see if EPA quantified transport. EPA did not quantify transport, but simply assumed a uniform concentration of pollutants across all regions of the country when accounting for both transport into an area, and for pollutants from natural sources. A fuller discussion of how the 1996 NATA accounted for transport and background can be found on the NATA website at: <http://www.epa.gov/ttn/atw/nata/>. The NATA data, however, does show that upwind states have a greater risk from HAPs than Maine does, as illustrated in Figure 21, suggesting that transport is an important factor that must be addressed by MATI.

Unfortunately, the ATAC determined that there was not enough information currently available to quantify the impacts resulting from transport of pollutants into Maine. The ATAC is however, able to make the following qualitative assessment from research into transport of ozone & its precursors, particulate matter & its precursors, and mercury.

7.5.1 Information Needed to Assess Transport of a Pollutant

There are numerous factors that influence the transport of air pollutants. These factors are generally input into a computer model that will predict ambient concentrations of pollutants at a given location. Actual measurements at those locations are used to calibrate the model, or to see if it has been designed properly. Emission inventories are used to determine if local releases are contributing to the ambient air concentrations, in addition to the concentrations predicted by the long-range transport model.

Sophisticated models are used to predict transport of pollutants. Accurate meteorological, emissions, and chemical data must be input into the model to obtain accurate predictions. Table 18 shows typical input parameters for transport models. The model must also be validated using monitoring data.

⁵² Ozone is a criteria air pollutant, rather than a Hazardous Air Pollutant or Air Toxic, and is therefore outside of the charge of the MATI.

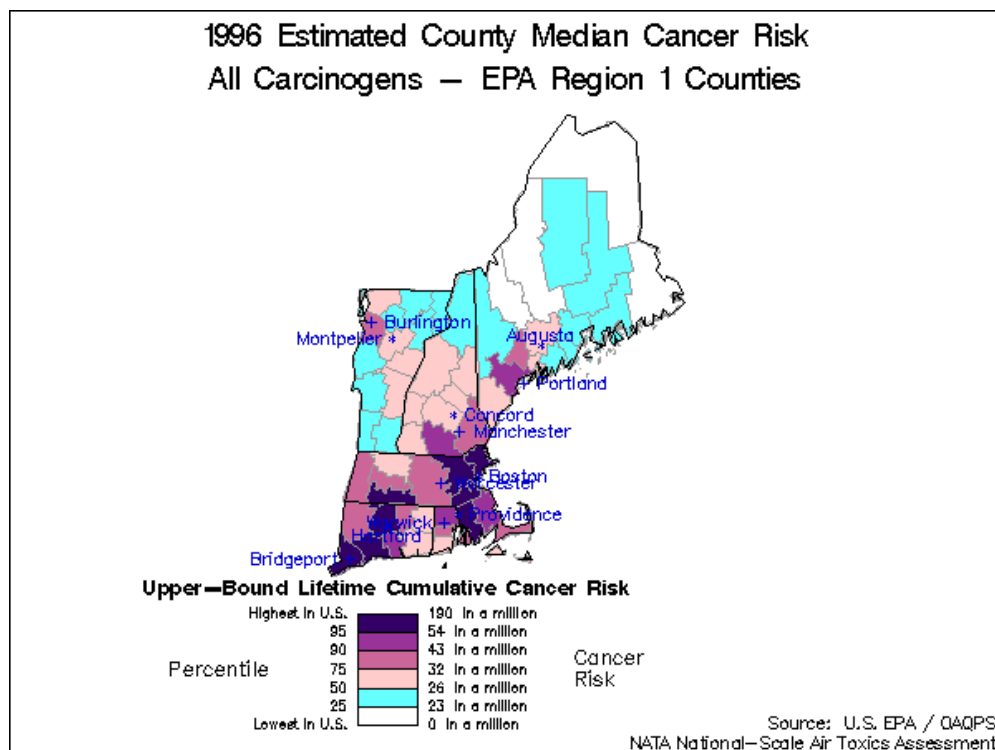
Table 18: Typical Input Data for Pollutant Transport Models

Meteorology	Emissions	Chemistry
Wind speed	Source Category Type (Point, Area, Mobile)	Photochemistry
Wind Direction	Location	Residence time or half-life
Temperature	Emission Rate (hourly best)	Reactions in the clear skies
Relative Humidity	Exit Velocity	Reactions in clouds or precipitation
Cloud type	Exit Temperature	volatility
Precipitation	Release stack height	water-solubility
Solar Radiation	Stack Diameter	mass
Height of the Mixing Layer		half-life
		molecular weight
		settling velocity

The meteorological information must be known to accurately predict movement of air masses. This information is needed on a regional scale, both upwind of release points and downwind along the transport route, as well on a local scale at or near the receptor site. Meteorological information is needed at differing heights as well. This information is used to predict where emission releases will travel and the time that it will take to reach a receptor. Local information is needed to determine the portion of Air Toxics that come from local releases and to help predict where a transported particle mass will eventually land. Meteorological information is available from national networks of weather stations, and from weather instruments operated by MEDEP at monitoring sites.

Of course, it is also important to have accurate AT emission information from the release point out of state, and along the transport route. This type of information is contained in EPA's National Emissions Inventory, down to the census tract level. The most recent information available from the NEI is for the emission year of 2002. Additional information may be available from individual states along the transport route. These state inventories generally inform the national emissions inventory, and the NEI uses consistent inventory approaches so that results are comparable from state to state. However, the ATAC has learned first hand that all emissions inventory information needs to be carefully reviewed to ensure its accuracy. For example, the emission inventory work that has been completed by ATAC identified several air toxics that were significantly over-estimated in the 1996 NEI inventory, and other categories where the inventory was incomplete. Therefore, the cumulative risk values shown in Figure 21 are inaccurate. Never-the-less, Figure 21 shows the relative risk posed by air toxics in the region; that is, risks from Air Toxic risks is lower in Maine and northern New England than in the southern New England states.

Figure 21 : National Air Toxics Assessment Cancer Risk for New England in 1996



The chemical properties of a given AT will also influence the amount that can be regionally transported. Pollutants that rapidly degrade or rapidly settle will not travel as far as long-lived, lighter pollutants. Models must predict chemical reactions with other compounds in sunlight, within clouds or precipitation, and at varying temperatures. For instance, benzene will form ozone under sunny and hot conditions, but will remain as benzene under colder or cloudy conditions. Some pollutants will be more reactive in a water environment so will react in clouds or precipitation. All of these factors must be considered to accurately predict the amount of an AT that will be transported.

Accurate monitoring of the pollutant at the receptor site is also needed to calibrate models. Meteorologists prefer frequent monitoring, such as hourly, in order to make accurate apportionment of long range and local transport. Monitoring for ozone precursors has demonstrated that to accurately understand how chemicals are transforming in the atmosphere as they are transported monitoring is needed at the receptor location and along the predicted transport route. Air masses do not stay at the same height as they move downwind, so ideally the meteorologist will have monitoring information along the transport route, both at the surface and aloft.

When undertaking transport studies, some of the questions that must be answered are:

- What regions have the greatest impact from transported pollutants?
- What is the magnitude of the impact relative to local sources?
- How does mixing of aged pollution with fresh emissions during transport affect pollution formation and distribution?
- What is the role of the sea breeze circulation in shaping local air quality?

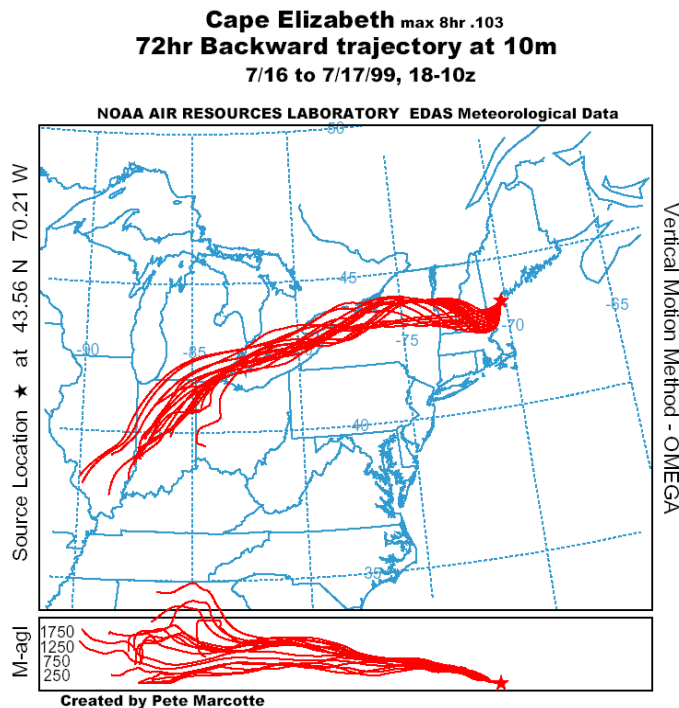
- What is the role of the regions complex terrain promoting the exchange of pollution between the polluted boundary layer and the free troposphere?
- What is the relative role of biogenic (natural sources) and anthropogenic (man-made) emissions in the formation of pollution in the region?
- What is the role of nighttime chemistry and transport in determining the distribution and composition of regional pollution?
- How does the atmospheric chemistry of biogenic emissions vary from night and day?

While a detailed transport analysis of each Air Toxics is beyond the scope of this project, the ATAC believes that the information in sections 7.5.2 through 7.5.5 is useful in assessing general trends in pollution transport into Maine.

7.5.2 Back Trajectory Analysis

Figure 22: Back Trajectory Analysis

Figure 22 shows a back trajectory analysis of a particle of air flowing into the Cape Elizabeth Photochemical Assessment Monitoring Station (PAMS) over a 3 day period when ozone levels were unusually high. MEDEP established this monitoring location to track import of ozone forming pollutants. The Cape Elizabeth PAMS is located at Two Lights State Park, on the outskirts of the Portland metropolitan region, between the center of Portland and Boston. MEDEP has used this type of back trajectory analysis to show weather systems picking up pollutants from locations well out-side of Maine can deposit those pollutants in the state. It also demonstrates that pollutants may be transported above upwind surface monitoring stations along the pollutant trajectory. These types of analysis are used on a large scale. Smaller scale models are then used to determine the influences of local meteorological events, such as a sea breeze.



7.5.3 Satellite Analysis

Analysis of satellite images also suggests that pollutants are transported into Maine. Figure 23 shows a satellite image during a heat wave in August of 2002. The white features are clouds, and the darker coloration shows visible pollutants moving off the East Coast and out to the gulf of Maine. On shore breezes coupled with temperature

differentials as the mass moves from sea to land can then lead to deposition of these pollutants along Maine's coast. Satellite images have also lead to a better understanding of general weather circulation patterns. This in turn can be used with simplistic GIS emission maps to show the possible transport of pollutants in weather systems from other regions of the country.

Figure 23: Satellite Image Showing Regional Haze in the Gulf of Maine on August 14, 2002



7.5.4 Use of PAMS Data to Assess HAP Transport

The benchmarking subcommittee reviewed analyses provided by MEDEP's Chief Meteorologist regarding data from four PAMS sites. Transport has been shown to be a significant source of ozone in Maine.⁵³ The purpose of the assessment was to use available data to shed light on transport of air toxics. MEDEP reviewed data from the

⁵³ Secretariat of the Commission for Environmental Cooperation, "Long-Range Transport of Ground-Level Ozone and Its Precursors: Assessment of Methods to Quantify Transboundary Transport Within the Northeastern United States and Eastern Canada (Montreal Canada, 1997).

sites in and upwind from Maine including all Type 1 sites. The characteristics of the four sites with relevant and usable data are shown in Table 19.

Table 19: PAMS Sites Analyzed for the Maine Air Toxics Initiative

Site Location	Operation Dates	Site Type
Summit of Cadillac Mountain, ME	1997-2004	4. Extreme Downwind for Boston
Cape Elizabeth, ME	1994-2004	4. Extreme Downwind for Connecticut
Newbury, MA	1995-2003	3. Maximum ozone site for Boston
Lynn, MA	1994-2003	2. Maximum emissions site for Boston

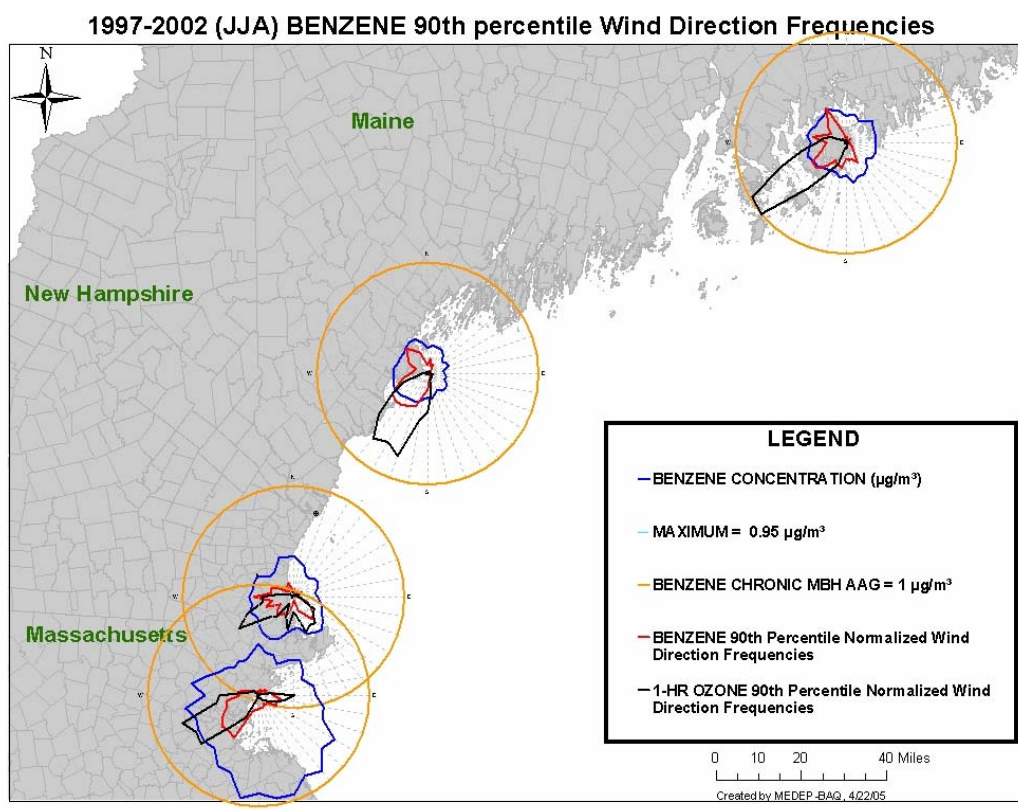
Since ozone forms as a result of the interaction of photo reactive VOCs and nitrogen oxides in the presence of sunlight, the highest concentration of ozone is found around mid-day at the site of formation. Conversely, as VOC's form ozone, their concentrations will decrease at mid-day. Concentrations of long-lived VOCs, such as benzene, tend to increase at night and during morning and evening rush hours, since ozone formation rates are low at those times.

7.5.4.1 Benzene Concentrations as a Function of Latitude and Wind Direction

Benzene is the HAP that has the highest residence time in air, and can be used to assess potential transport of similarly long-lived HAPs from outside the state. Figure 24 shows a MEDEP assessment of 6 years of benzene concentrations at 4 PAMS sites along the Massachusetts and Maine Coasts. On this map are plotted the wind direction frequencies for when benzene and ozone concentrations were their highest (90th percentile, or top 10%), along with the average benzene concentrations by wind direction, and Maine ambient air guideline (MAAG) for benzene (1 µg/m³). Results show that the highest benzene concentrations, as expected, are near the Type 2 site at Lynn with all average site concentrations below an ILCR of 1 in 100,000. Results also show both a local and regional transport signal at the 2 sites in Maine where one lobe of the 90th percentile concentration wind direction frequencies are from the larger populated areas (Portland and Bangor) near the site, and the other much larger lobe is correlated with the 90th percentile ozone concentration wind direction frequencies which are due to regional transport. This suggests that at these sites a portion of the benzene is transported into Maine from out-of-state.

Unlike the concentrations of benzene shown in Figure 20, the concentrations of benzene found in the Maine PAMS sites typically do not exceed the 1 in 100,000 ILCR level. The PAMS sites are specifically located in remote areas to avoid local sources of VOCs. Note also that, in support of the 1996 NATA risk map shown in Figure 21, benzene concentrations are higher in southern New England, than in Maine.

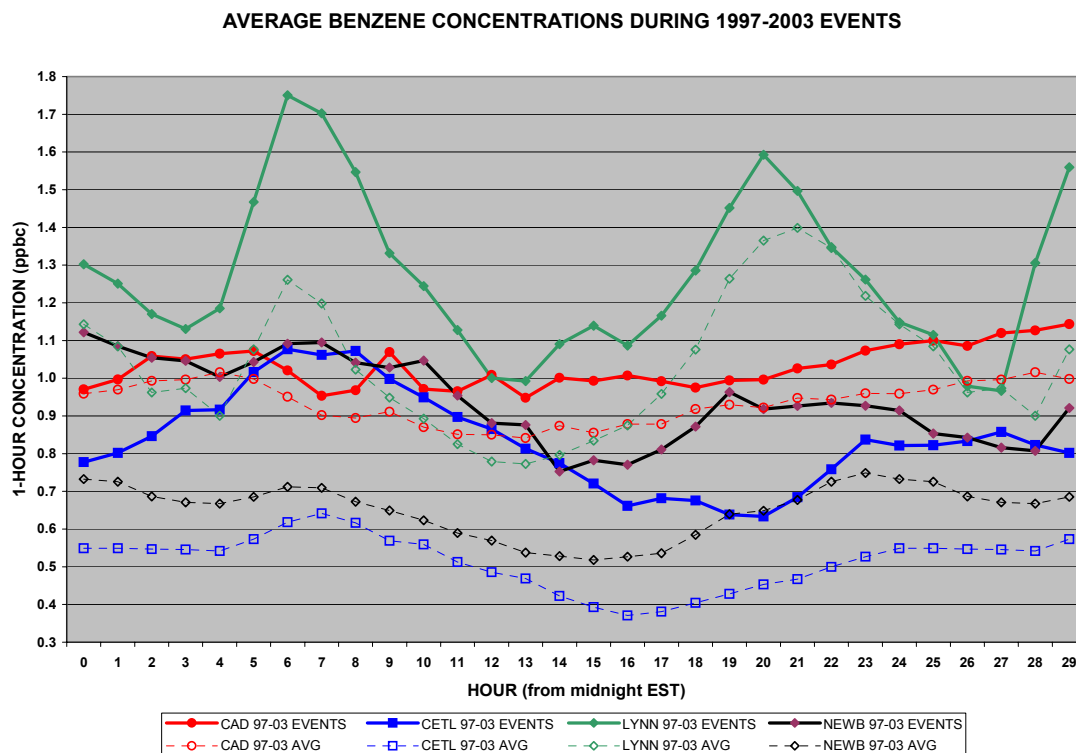
**Figure 24: Concentration and 90th Percentile Wind Direction Frequency Analysis
Plots of Benzene at PAMS sites along the Massachusetts and Maine Coastline**



7.5.4.2 Diurnal Benzene Trends at the Four PAMS sites

An analysis of diurnal (daily) benzene trends at each of the four sites (Figure 25) also shows transport signals. Two diurnal plots are shown for each site. The dashed lines represent the diurnal pattern using all of the data. The solid lines represent data only from days where ozone concentrations exceeded the 8-hour ozone National Ambient Air Ozone Standard (NAAQS) in both states (ozone events). There are typically 2 peaks of benzene concentrations that are correlated with morning and afternoon rush hour traffic. A regional transport signal can be seen at all sites (including Lynn) where the event pattern concentrations for all hours are higher than the average pattern. For all sites, except Cadillac, the morning peak occurs at about the same time of day with Lynn showing the strongest signal. However the afternoon peak occurs later in the day as one moves up the coastline, which again shows the transport signal. The diurnal peaks are more pronounced at the southern sites, while Cadillac's concentrations remain relatively constant. Thus, the diurnal pattern analysis supports the idea that at least a portion of the benzene concentrations at Cadillac and Cape Elizabeth are emitted outside of Maine and then are transported into Maine.

Figure 25: Diurnal Benzene Trends (all days and ozone event days only) showing transport signals at Four New England PAMS sites



7.5.4.3 Relative ranking of HAPs and VOCs at the four PAMS sites

Another method of assessing whether transport plays a role in Maine's ambient levels of air toxics is to assess the relative ranking of the 8 HAPs to the other 46 VOCs monitored in the PAMS program. The ratio of Benzene to Toluene (or any other ratio of less-reactive-VOC to more-reactive-VOC) can give an indication of the relative age of the air reaching a monitoring site. Table 20 shows the average rank (of the average, 50th, 70th and 90th percentile concentrations), by weight, of the HAPs at the 4 PAMS site. In Lynn, benzene is usually compound number 13 or 14 when all of the 54 compounds are listed in order of their weights, in a parts-per-billion-carbon basis, while toluene is usually ranked between 2 and 3. At Cadillac, benzene is usually ranked as compound 5 or lower, while toluene is ranked around 7. The difference is attributed to the age of the air mass. The ranks shown at Lynn are typical of an air mass that is near the source of VOC emissions, where the short-lived compounds, such as toluene, have not all been transformed into ozone. Cadillac, on the other hand, has a different composition. Cadillac's ranking is typical of an aged air mass, where most of the short lived compounds have already been converted into other compounds. The relative ranking changes as one moves from the south (recent emissions) to the north (aged air) suggests that some of the benzene in Maine is

being transported from out of state. The decreased difference in rank between benzene and toluene suggests that the short-lived HAPs degrade before reaching Maine, and are not transported from out of state.

Table 20: Average Rank of HAPs to Other VOCs by Weight (ppbc) at Four PAMS Sites

		CADILLAC	CAPE ELIZABETH	NEWBURY	LYNN
		AVERAGE RANK	AVERAGE RANK	AVERAGE RANK	AVERAGE RANK
TOLUENE	45202	7.3	4.8	3.1	2.6
M/P-XYLENE	45109	17.2	13.0	6.2	6.8
BENZENE	45201	4.9	10.7	11.6	13.7
2,2,4-TRIMETHYLPENTANE	43250	14.6	14.0	10.9	13.2
N-HEXANE	43231	22.1	15.8	13.0	14.8
O-XYLENE	45204	23.9	23.1	21.5	18.7
ETHYLBENZENE	45203	21.1	24.7	20.5	20.3
STYRENE	45220	15.6	31.1	29.6	35.3
ISOPROPYLBENZENE (CUMENE)	45210	30.3	41.0	49.5	51.0

7.5.4.4 Transport Conclusions From PAMS Data

Based on the PAMS data analysis of the 8 HAPs monitored, only Benzene had concentrations anywhere near the Maine Ambient Air Guidelines. An assessment of the data indicates that local emissions and long range transport are both factors contributing to benzene concentrations at Cadillac and Cape Elizabeth. It is likely that other long-lived HAPs are also transported into the state, while concentrations of short-lived HAPs are due to local emissions.

7.5.5 Mercury Transport

As discussed in section 6.2.2, mercury is a serious public health, economic, and environmental problem for Maine. Atmospheric deposition of mercury is responsible for the majority of the mercury found in Maine fish and wildlife⁵⁴. EPA's RELAP model predicts that the majority of the airborne mercury atmospherically deposited in Maine is from sources outside the state (see Figure 26)⁵⁵. Atmospheric Mercury is either scrubbed from the atmosphere by rain and snow ("wet deposition"), or is deposited as particulate matter ("dry deposition").

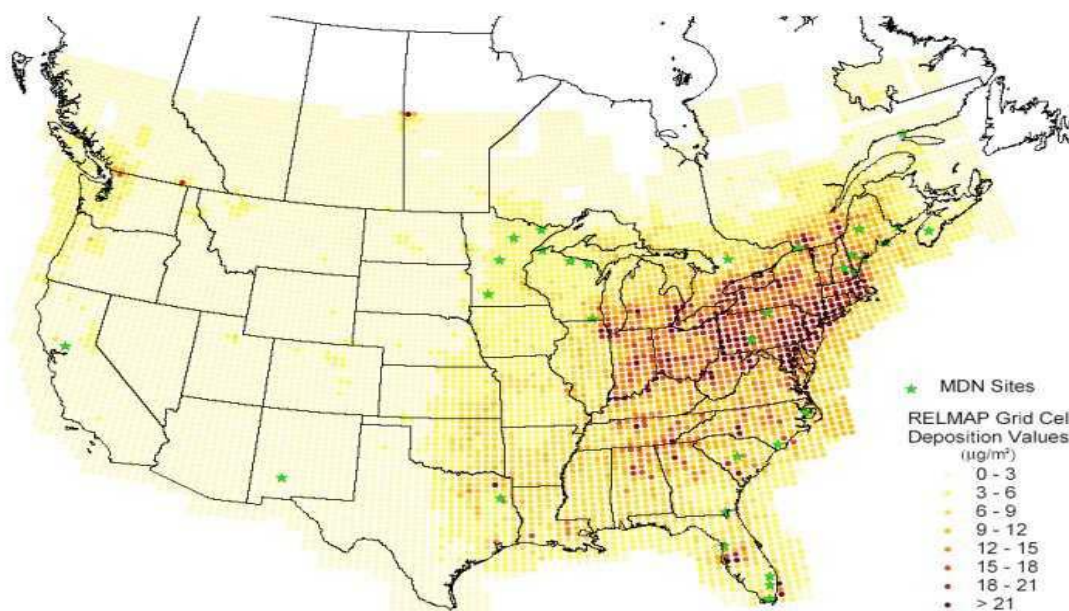
⁵⁴ NESCAUM, NEWMOA, NEIWPC & EMAN; February, 1998; "Northeast States and Eastern Canadian Provinces Mercury Study, A Framework for Action" (North East States for Coordinated Air Use Management , 101 Merrimac Street, 10th Floor, Boston, MA, 02114)

⁵⁵ MDN 2002 1st Quarter Preliminary Data Report; MDN North East, Frontier Geosciences Inc., Seattle WA, [http://www.frontiergeosciences.com/MDN_Data/\(05\).PDF](http://www.frontiergeosciences.com/MDN_Data/(05).PDF)

Maine DEP currently measures wet deposition of mercury at four locations in Maine: Acadia National Park, Greenville, Bridgton, and Freeport. The sites are part of the Mercury Deposition Network (MDN) established by the National Atmospheric Deposition Program (NADP). MEDEP and EPA use the analytical results of the actual mercury concentrations deposited in Maine rainwater to verify the accuracy of EPA's atmospheric transport and depositional model and to document potential depositional trends. Wet deposition monitoring data collected in Maine between 1998 and 2001 have validated the mercury deposition predicted by EPA's RELMAP model as shown in Figure 26. The model predicted deposition in the range of 3 to 10 $\mu\text{g}/\text{m}^2$ for Maine⁵⁶, and the 1998/2001 MDN average wet deposition ranged from 5 to 10 $\mu\text{g}/\text{m}^2$ ⁵⁷.

It is likely that other metals, in addition to mercury, are transported into the state where they are subsequently deposited.

Figure 26: 1998 MDN Sites and RELMAP Grid Cell Deposition Values.



Source: MDN 2002 1st Quarter Preliminary Data Report; MDN North East, Frontier Geosciences Inc., Seattle WA.⁵⁸

7.6 Conclusions of the ATAC Review of AT Monitoring Data & Transport Assessment

The ATAC reviewed Air Toxics Monitoring Data to ensure that the compounds that are detected in Maine's air were considered in the above screening risk assessment.

⁵⁶ NESCAUM, NEWMOA, NEIWPC & EMAN; February, 1998, "Northeast States and Eastern Canadian Provinces Mercury Study: A Framework for Action." (North East States for Coordinated Air Use Management, 101 Merrimac Street, 10th Floor, Boston, MA, 02114)

⁵⁷ Saball, Doug et. al., July, 15, 2003, "Mercury Deposition in Maine: Status Report 2003" (Maine DEP, BAQ, 17 SHS, Augusta, ME 04333)

⁵⁸ MDN 2002 1st Quarter Preliminary Data Report; MDN North East, Frontier Geosciences Inc., Seattle WA, [http://www.frontiergeosciences.com/MDN_Data/\(05\).PDF](http://www.frontiergeosciences.com/MDN_Data/(05).PDF)

Monitoring for arsenic, chlorine, chromium, manganese and nickel at monitoring sites located in Acadia National Park, Bridgton, Casco Bay, Moosehorn Wildlife Refuge and Presque Isle as well as the NATA modeled concentrations for these HAPs demonstrated ambient air concentrations substantially below an Incremental Lifetime Cancer Risk (ILCR) of 1 in 100,000 or a Health Index (HI) of 1. Monitoring for benzene at sites in Cape Elizabeth and Acadia National Park compared well with the NATA modeled background concentration for benzene of between an ILCR of 1 in 1,000,000 and 1 in 100,000. Monitoring in Rumford and the Portland site indicated benzene concentrations between 1 in 100,000 and 1 in 10,000. The results suggest the need for further evaluation of “hot spots” impacted by local emission sources. Monitoring for carbon tetrachloride and chloroform in Rumford validate the NATA assumed background concentration at ILCR between 1 in a million and 1 in 100,000. The ATAC determined that for most areas, the ambient air monitoring results are consistent with concentrations predicted by NATA, indicating that the NATA risk assessment should be relatively accurate.

Transport of Air Toxics into Maine is an issue that MEDEP should continue to assess with input from the ATAC. While understanding contributions from transport is an important issue, in-state actions still need to be taken to reduce air toxic threats. These actions should be developed by ATAC using the process described in the Maine Air Toxics Initiative Scope of Work.

8. FINAL AIR TOXICS PRIORITY LIST

Based on the Information described above, the ATAC has developed the Air Toxics Priority List shown in Table 21

Table 21: Final Air Toxics Priority List (note, this list has not been reviewed nor endorsed by the full Air Toxics Advisory Committee)

	Pollutant Category	Basis
1	Acrolein	Tox-Weight & Benchmarking
2	POM	Tox-Weight & Benchmarking
3	Manganese	Persistence
4	Formaldehyde	Tox-Weight & Benchmarking
5	Nickel	Tox-Weight & Benchmarking, Persistence
6	1,3-Butadiene	Tox-Weight & Benchmarking
7	Diesel PM	Tox-Weight & Benchmarking
8	2,4-Toluene Diisocyanate	Tox-Weight & Benchmarking
9	Sulfuric Acid	Tox-Weight & Benchmarking
10	Benzene	Tox-Weight & Benchmarking
11	Unknown Pollutants	Unevaluated Risk
12	Lead	Persistence
13	Cadmium	Persistence
14	Dioxins	Persistence & Bioaccumulation

	Pollutant Category	Basis
15	Chromium	Persistence
16	Arsenic	Persistence
17	Cyanide & Compounds	Persistence
18	Mercury	Persistence & Bioaccumulation
19	Brominated Flame Retardants	Persistence & Bioaccumulation
20	PM from Nano-Technology	Unevaluated Risk
21	Acetaldehyde	Potential hot-spot pollutant
22	Tetrachloroethylene (Perchloroethylene)	Back-ground pollutant
23	Chloroform	Back-ground pollutant
24	Carbon Tetrachloride	Back-ground pollutant
25	Ethylene Dichloride	Back-ground pollutant
26	Ethylene Dibromide	Back-ground pollutant
27	methyl bromide	Potential hot-spot pollutant
28	chlorine	Uncertainty in emission factor
29	hydrochloric acid	Uncertainty in emission factor
30	chlorine dioxide	Historically Significant

9. SOURCES OF AIR TOXIC EMISSIONS

The toxicity-weighted emissions inventory can also be used to determine which sectors have the greatest releases, on a toxicity-weighted basis. Table 22 shows the major emission sources based on the current estimated emissions inventory. The reader must be cautioned that the inventory conducted by this process has inherent uncertainties, as discussed above. For instance, the two top categories would change places if the pulp and paper companies did not use a lower emission factor for emission of acrolein from their wood fired boilers than all of the other wood fired sources. Also the categories are arbitrary in that the sources could be grouped differently. For instance, all wood combustion could be grouped together rather than having it segregated into residential, commercial and industrial combustion. Additionally, some category lines are blurred; for instance, much of the toxicity-weighted emissions for the manufacturing sector are due to fuel combustion. Nonetheless, the inventory will be useful in determining which sectors should be focused on for inventory refinement, or for possible mitigation efforts, as the Maine Air Toxics Initiative moves into the solutions phase.

Table 22: Maine Sources of Air Toxic Emissions based upon the 2005 Estimated Toxicity-Weighted Inventory

Source Category	Source Subcategory	2005 Estimated Toxicity Weighted Inventory (unitless)	% of Toxicity Weighted Inventory
Industrial Combustion	Wood (industrial) Boiler	6,412,455,181	26%
	Electric Generation	108,378,125	0.4%
	Miscellaneous Fuel (industrial) - Small	76,834,387	0.3%
	Residual Oil (industrial)	37,547,461	0.2%
	Distillate Oil (industrial) Boilers	9,190,940	0.04%
	Natural Gas (industrial) Boilers	1,771,176	0.01%
	<i>Industrial Combustion Total</i>	<i>6,646,177,269</i>	<i>27%</i>
Manufacturing	Pulp & Paper Industry	3,381,476,231	14%
	Oriented Strand Board	1,561,392,712	6%
	Wood Products	32,751,956	0.1%
	Metal Fabrication	24,083,520	0.1%
	Brick & Concrete Manufacturing	19,689,635	0.1%
	Plastics Manufacturing	18,644,354	0.1%
	Aerospace Industry	17,627,438	0.1%
	Food Processing	7,634,076	0.03%
	Tannery	7,059,003	0.03%
	Asphalt Concrete-Rotary Dryer: Conventional Plant	6,009,760	0.02%
	Electronics	4,821,316	0.02%
	Printing Press	3,726,474	0.02%
	Concrete, Gypsum, Plaster Products	2,864,570	0.01%
	Textiles	2,649,381	0.01%
	Paint & Chemical Manufacturing	1,667,956	0.01%
	Asphalt Application (commercial)-All Solvent Types	1,283,549	0.01%
	Metal Working-Anodizing	1,167,880	0.005%
	Metal Working-Electroplating	1,103,380	0.004%
	Metal Working-Other	759,791	0.003%
	Shoe Manufacturing	510,150	0.002%
	Chemical Manufacturing-Other	463,565	0.002%
	Foam Production	460,866	0.002%
	Brick & Cement Manufacturing	431,586	0.002%
	Boat Manufacturing	395,592	0.002%
	Other	307,362	0.001%
	Boat/Ship Building & Repair	261,654	0.001%
	Metal Working-Primary Metal Production Processes	160,296	0.001%
	Reactor (Polyurethane)-Plastics Production	126,352	0.001%
	Metal Working-Plating: Metal Deposition	115,630	0.0005%
	Thermometer Manufacture	49,627	0.0002%
	Analytical Laboratory	38,246	0.0002%
	Dental Alloy (Mercury Amalgams) Production	38,149	0.0002%
	Rubber Manufacturing	37,788	0.0002%
	Metal Working-Electroplating Chrome	35,260	0.0001%
	Fiberglass	9,013	0.00004%
	Light bulb Manufacturing	23	0.000001%

Source Category		Source Subcategory	2005 Estimated Toxicity Weighted Inventory (unitless)	% of Toxicity Weighted Inventory
<i>Manufacturing Total</i>			5,099,854,140	21%
On-Road				
Mobile		Light Duty Gas Vehicles	2,744,872,848	11%
		Heavy Duty Diesel Vehicle	937,160,261	4%
		Heavy Duty Gas Vehicles	677,741,243	3%
		Light Duty Gas Truck	502,232,625	2%
		Light Duty Diesel Vehicle	130,914,716	1%
		Motorcycle	37,197,315	0.2%
		Light Duty Diesel Truck	2,917,440	0.01%
<i>On-Road Mobile Total</i>			5,033,036,449	20%
Off-Road				
Mobile		Gas 2-Stroke	1,675,624,869	7%
		Diesel (off-road vehicle)	895,666,432	4%
		Gas 4-stroke	500,357,045	2%
<i>Off-Road Mobile Total</i>			3,071,648,347	12%
Residential				
Combustion		Wood (res) heating	1,158,173,323	5%
		Distillate Oil (res) Heating	144,532,046	1%
		Coal (res) Heating	2,763,328	0.01%
		Natural Gas (res) Heating	1,073,051	0.004%
<i>Residential Combustion Total</i>			1,306,541,749	5%
Open Burning				
		Structure Fires	694,932,258	3%
		Forest Wildfires	374,681,296	2%
		Open Burning-Brush Species Unspecified	11,919	0.00005%
		Open Burning-Leaf Species Unspecified	11,919	0.00005%
		Open Burning-Land Clearing Debris	192	0.000001%
<i>Open Burning Total</i>			1,069,637,584	4%
Commercial				
Combustion		Wood (commercial) Boilers	679,386,193	3%
		Residual Oil (commercial) Boilers	40,645,349	0.2%
		Distillate Oil (commercial) Boilers	39,859,239	0.2%
		Coal (commercial) All Boiler Ty	287,023	0.001%
		Natural Gas (commercial) Boilers	281,548	0.001%
<i>Commercial Combustion Total</i>			760,459,353	3%
Commercial				
Solvent Use		Graphic Arts-All Solvent Types	557,550,946	2%
		Automobile Repair & Refinishing	10,583,907	0.04%
		Dry Cleaning-Perchloroethylene	5,855,137	0.02%
		All Automotive Aftermarket Products	4,649,074	0.02%
		Degreasing-All Solvent Types	3,707,723	0.01%
		All Adhesives and Sealants	2,741,133	0.01%
		Traffic Markings	730,828	0.003%
		Paint Stripper User	586,704	0.002%
		Household Products- Methylene Chloride Processes	541,076	0.002%
		Dry Cleaning-All Solvent Types	117,486	0.0005%
		Miscellaneous Products (consumer/com)-All Solvent Types	80,086	0.0003%
		Laboratory Fugitive Emissions-Hospitals	35,321	0.0001%

		2005 Estimated Toxicity Weighted Inventory (unitless)	% of Toxicity Weighted Inventory
Source Category	Source Subcategory		
	Commercial Solvent Use Total	587,179,422	2%
Household Products	All FIFRA Related Products	489,217,068	2%
	All Household Products	1,205,437	0%
	All Personal Care Product	22,696	0%
	Fluorescent Lamp Breakage	66,236	0%
	Swimming Pools	8,599,881	0%
	Household Products Total	499,111,319	2%
Aviation Fuel combustion	Aviation	315,387,288	1%
	Diesel	12,953,520	0.1%
	Aviation Fuel combustion Total	328,340,808	1%
Commercial Marine Fuel combustion	Diesel (CMV)	153,827,036	1%
	Residual (CMV)	52,459,917	0.2%
	Commercial Marine Fuel combustion Total	206,286,953	1%
Fuel Distribution	Gas Service Stations-Stage 1	46,918,959	0.2%
	Aviation Gasoline Distribution: Stage I	23,154,943	0.1%
	Gas Service Stations-Stage 1: Balanced Submerged F	7,639,778	0.03%
	Gas Service Stations-Stage 2	3,917,215	0.02%
	Gas (Bulk Stations/Terminals: Breathing Loss)	3,061,394	0.01%
	Aviation Gasoline Distribution: Stage II	1,601,789	0.01%
	Oil Terminal	409,054	0.002%
	Natural Gas: Withdrawal Loss-Fuel Storage - Pressu	35,232	0.0001%
	Fuel Distribution Total	86,738,364	0%
Waste Handling	Sewage Treatment-Entire Plant	24,965,422	0.1%
	Large Municipal Waste Incinerator	21,559,231	0.1%
	Human Cremation	6,792,422	0.03%
	Backyard Burning - Household Waste	2,492,880	0.01%
	All Catastrophic/Accidental Releases	2,260,642	0.01%
	Landfill	612,073	0.002%
	Animal Cremation	182,725	0.001%
	Waste Handling Total	58,865,395	0%
Surface Coating	Industrial Maintenance Coatings	25,135,142	0.1%
	Architectural Coatings	11,283,783	0.05%
	All Coatings and Related Products	3,428,967	0.01%
	Surface Coating-NEC	2,815	0.00001%
	Surface Coating Total	39,850,707	0%

10. ATAC CONCLUSIONS AND RECOMMENDATIONS

The ATAC has considered emissions and toxicity to establish a toxicity-weighted inventory, as shown in Table 7. To establish which compounds on the Toxicity-Weighted inventory should be the focus of further efforts, the list was compared to the risk estimates in NATA, which the ATAC had updated to current emission levels. The ATAC then considered other factors, to derive the Air Toxic Priorities List that is contained in Table 21. The ATAC has also developed recommendations for the next steps in the Maine Air Toxics Initiative.

As the ATAC moves forward, it must be aware of the uncertainties in the development of the ATPL, and take these into consideration when it develops solutions. Further inventory refinement and risk assessment may be necessary before a solution can be fully considered. The assessment in this document should help the ATAC to focus efforts towards those areas where a refinement is most necessary. The following uncertainties in the factors used in the ranking should be considered by subcommittees in the solutions phase, when assessing the feasibility and necessity of reduction:

1. lack of emissions data from certain source categories known to emit the pollutant will under estimate risk from that category;
2. uncertainty in using a toxicity-weighted emissions and benchmarking approach, rather than a full risk assessment, increases the uncertainty of risk reduction efforts;
3. the under-weighting of carcinogens by the RSEI toxicity factors will mean that unacceptable risks may still remain after solutions are developed for the top tier of pollutants;
4. impacts from mixtures of chemicals may be underestimated in the “pollutant by pollutant” analysis undertake to develop the ATPL, and greater risk reductions than estimated may result as individual pollutant risks are reduce;

The ATAC has **not** come to consensus on the following additional actions that should be undertaken by ATAC

- 1) ATAC should move forward to complete the steps in the MATI Scope of Work. ATAC subcommittees should be formed to develop short and long-term actions, with clear steps and timeframes for ATAC review. The next steps should include:
 - a) Explore the issue of localized areas of high impacts, such as the states larger urban areas. MEDEP should conduct a screening analysis on where these areas might be, based on the census tract level in the 1999 NATA, and other available information. This screening assessment would be used to prioritize where focused inventories, modeling, risk assessments and/or monitoring should be conducted.
 - b) Prioritize areas to reduce uncertainty that is described in this analysis, and then begin to work on those problem areas. In particular:

- i) the emission factors for metals and acrolein from combustion boilers should be refined.
 - ii) a focused effort should be made to verify all significant emission sources of 2,4-Toluene Diisocyanate.
 - iii) The activity data for residential wood burning should be verified through a Maine specific survey.
- Any refinements in the inventory should be done in parallel with developing risk reduction alternatives.
- c) Develop subcommittees to explore short and long-term reduction strategies for pollutants on the Air Toxics Priority List, focusing on ways to reduce the most risk for the least cost.
 - i) Lack of emissions data from certain source categories will under estimate risk from that category.
 - ii) Uncertainty in using a toxicity-weighted emissions approach rather than a full risk assessment increases the uncertainty of risk reduction efforts.
 - iii) Low or no-cost solutions should be implemented in the near-term, but it may be necessary to conduct a refined, localized emission inventory, modeling, and risk-assessment before undertaking costly solutions.
 - iv) Regulations that are already on the books and on the way should be considered when developing emission reduction options.
 - v) Particular attention must be paid to the economic feasibility of reducing risks posed by the background compounds Carbon Tetrachloride, Chloroform, Ethylene Dichloride, and Ethylene Dibromide.
 - 2) Have MEDEP develop an “Acceptable Risk” policy for Air Toxics through a stakeholder process.
 - 3) Explore a process for MEDEP to leverage existing resources to proactively evaluate unknown contaminants that may become future contaminants of air, water, land or food.
 - 4) Have MEDEP review its ambient air monitoring for HAPS to ensure that the pollutants on the ATPL are appropriately monitored. In particular, monitoring programs should include testing aldehydes and carbonyls at levels of health concern.
 - 5) Improvements in the methods used to derive the inventory for the MATI should be incorporated into the MEDEP’s inventory program, and conveyed to EPA’s national inventory program.

-END-